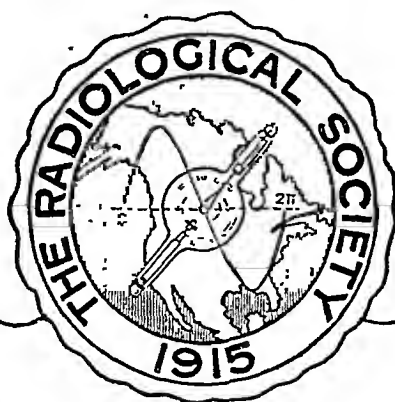


RADIOLOGY

A MONTHLY JOURNAL DEVOTED TO CLINICAL RADIOLOGY AND ALLIED SCIENCES

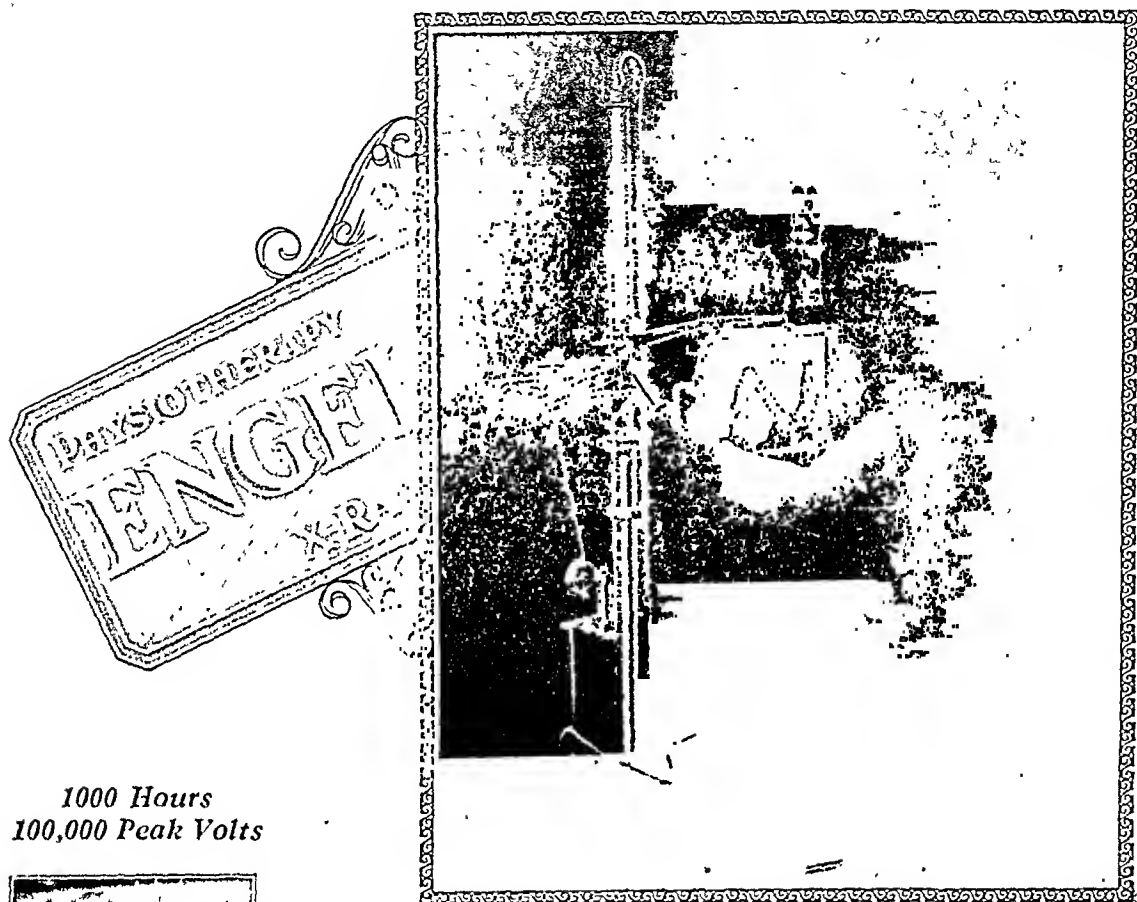
Owned and Published by
THE RADIOLOGICAL SOCIETY
OF NORTH AMERICA
As its Official Journal



JULY, 1927

Volume IX

Number 1



1000 Hours
100,000 Peak Volts



One of the stock 5-inch 30 milliamperes transformers used in the Fluoroscopic Unit which has been on a continuous test for more than 1000 hours at a load of approximately 110,000 volts or a 50 to 60% overload.

Out of the Darkness

YOUR eyes begin to adjust themselves to the inky blackness of the room—one reassuring glance at the softly illumined meters—your right foot presses the switch and a penetrating flood of X-Rays have flashed through glass and wood and tissue and bone to bring you a sharp, clear cut image of the field you wish to examine. A moving picture to verify your previous diagnosis—an unlimited field of usefulness; studying the size and action of the heart—following a barium meal through the gastro intestinal tract—the location of foreign bodies or the reduction of the simplest fracture. Powerful—handsome—compact—complete in a single unit at about one-half the price you would expect to pay.

Send for the book "The Vertical Fluoroscopic X-Ray Unit."

Your request will be answered by return mail.

THE ENGELN ELECTRIC COMPANY

X-Ray and Physiotherapy Equipment

SUPERIOR AVENUE AT EAST THIRTIETH STREET, CLEVELAND, OHIO

RADIOLOGY

A MONTHLY JOURNAL DEVOTED TO CLINICAL RADIOLOGY AND ALLIED SCIENCES

EDITORIAL STAFF

EDITOR

MAXIMILIAN JOHN HUBENY, M.D. . . . 25 East Washington St., Chicago, Illinois

ASSOCIATE EDITORS

BENJAMIN H. ORNDOFF, M.D. Chicago, Illinois
JOHN D. CAMP, M.D. Boston, Mass.

COLLABORATORS

L. J. CARTER, M.D.	AMEDEE GRANGER, M.D.
LEWIS G. COLE, M.D.	E. A. MERRITT, M.D.
ARTHUR U. DESJARDINS, M.D.	HENRY SCHMITZ, M.D.
HOWARD P. DOUB, M.D.	ALBERT SOILAND, M.D.
H. KENNON DUNHAM, M.D.	C. G. SUTHERLAND, M.B. (Tor.)
ARIAL W. GEORGE, M.D.	W. W. WASSON, M.D.
W. W. WATKINS, M.D.	

FOREIGN COLLABORATORS

HERBERT ASSMANN, M.D.	FEDOR HAENISCH, M.D.
A. E. BARCLAY, M.D.	MARTIN HAUDEK, M.D.
HENRI BECLERE, M.D.	GUIDO HOLZKNECHT, M.D.
FRIEDRICH DESSAUER, Ph.D.	ARTHUR F. HURST, M.D.
GOSTA FORSSELL, M.D.	ALBAN KOHLER, M.D.
RUDOLF GRASHEY, M.D.	HERMANN WINTZ, M.D., Ph.D.
FRANZ M. GROEDEL, M.D.	

CORRESPONDING MEMBERS

PROF. R. LEDOUX-LEBARD, Paris	DR. STANLEY MELVILLE, London
PROF. CLAUDE V. REGAUD, Paris	DR. REGINALD MORTON, London
DR. E. W. A. SALMOND, London	DR. D. M. MUIR, Exeter
DR. N. S. FINZI, London	PROF. DR. A. SCHULLER, Vienna
PROF. DR. R. KIENBOCK, Vienna	DR. S. GILBERT SCOTT, London

BUSINESS MANAGER

J. R. BRUCE 2429 University Avenue, Saint Paul, Minnesota

LONDON AGENTS

WILLIAM HEINEMANN (Medical Books), Ltd. . 20, Bedford St., London, W. C. 2, England

Contents of RADIOLOGY copyrighted by the Radiological Society of North America

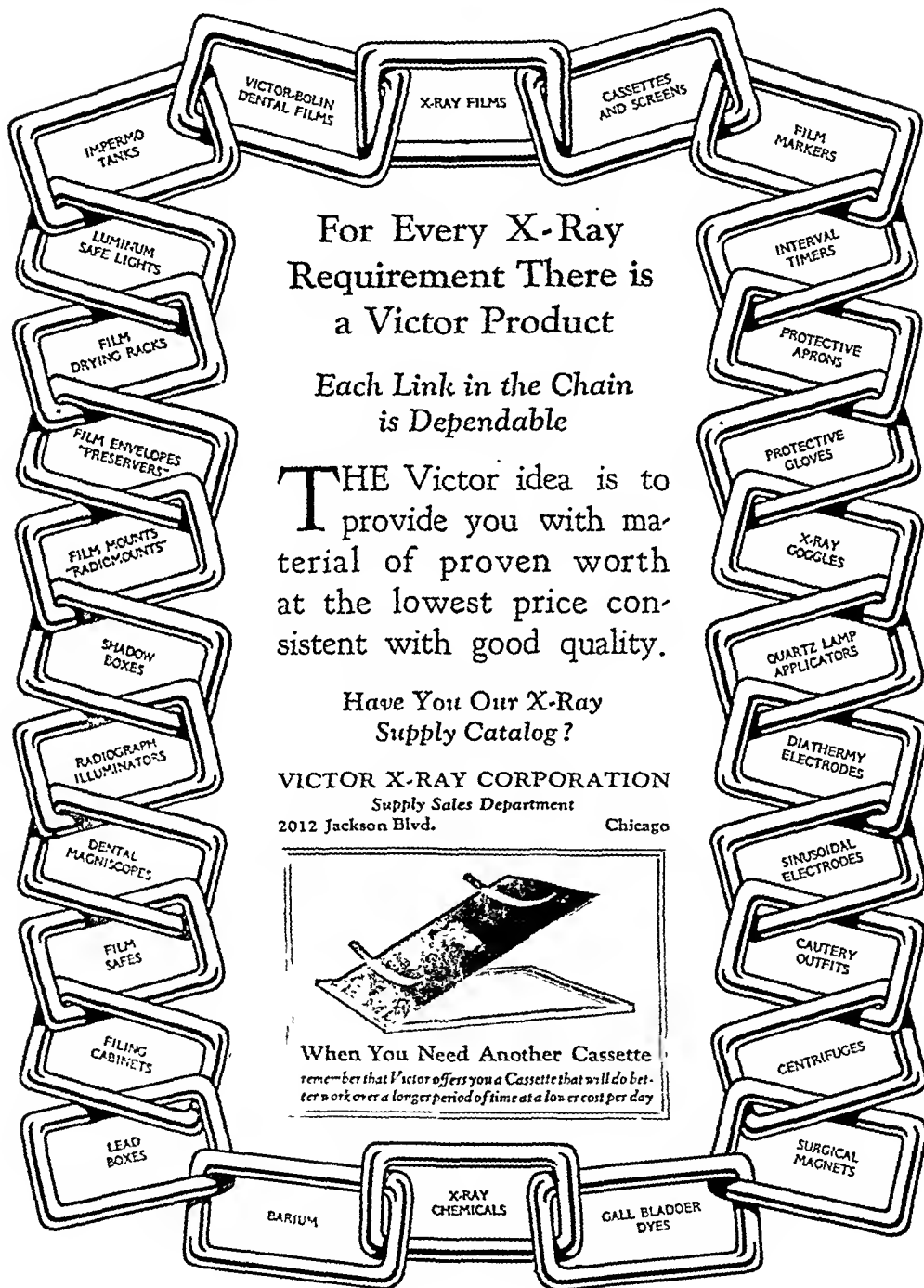
EVERY
VICTOR BRANCH
A SUPPLY STATION

A RELIABLE PROMPT
SUPPLY SERVICE FOR
EVERY LABORATORY



UNIFORM HIGH QUALITY
MEANS
LONG RUN ECONOMY

VICTOR BRANCHES
ARE LOCATED
IN ALL PRINCIPAL CITIES



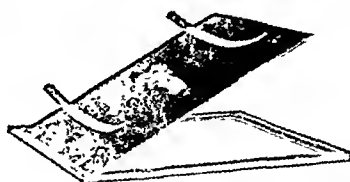
For Every X-Ray Requirement There is a Victor Product

*Each Link in the Chain
is Dependable*

THE Victor idea is to
provide you with ma-
terial of proven worth
at the lowest price con-
sistent with good quality.

Have You Our X-Ray
Supply Catalog?

VICTOR X-RAY CORPORATION
Supply Sales Department
2012 Jackson Blvd. Chicago



When You Need Another Cassette
remember that Victor offers you a Cassette that will do bet-
ter work over a longer period of time at a lower cost per day

RADIOLOGY

A MONTHLY JOURNAL DEVOTED TO CLINICAL RADIOLOGY AND ALLIED SCIENCES

CONTENTS FOR JULY, 1927

CHRONIC OBSTRUCTION OF THE SMALL INTESTINE. <i>By James T. Case, M.D., F.A.C.S., D.M.R.E. (Cambridge)</i>	1
CHRONIC OBSTRUCTION OF THE DUODENUM. <i>By Joseph C. Bell, M.D., J. Paul Keith, M.D., and D. Y. Keith, M.D.</i>	15
CHRONIC DUODENAL STASIS. <i>By Edward L. Kellogg, M.D., and William A. Kellogg, M.D.</i>	23
CHRONIC DUODENAL OBSTRUCTION. <i>By John A. Wolfer, M.D.</i>	39
CHRONIC OBSTRUCTION OF THE DUODENUM. <i>By William H. Holmes, M.D.</i>	43
A BRIEF REVIEW OF THE PHYSIOLOGY OF THE DUODENUM. <i>By A. C. Ivy, M.S., Ph.D., M.D.</i>	47
DISCUSSION: <i>Dr. A. A. Goldsmith, Dr. I. Seth Hirsch, Dr. Lewis Gregory Cole, Dr. Arthur R. Bloom, Dr. Wolfer, and Dr. Ivy</i>	56
THE FREQUENCY OF MULTIPLE ABDOMINAL LESIONS. <i>By Robert A. Arcus, M.D., and Arthur R. Bloom, M.D.</i>	60
LIMIT EXPOSURE IN RADIOGRAPHY. <i>By Ernst A. Pohle, M.D.</i>	65
EXPERIMENTAL STUDIES IN CHOLECYSTOGRAPHY. <i>By Julius Friedenwald, M.D., Maurice Feldman, M.D., and Francis X. Kearney, M.D.</i>	68
CASE REPORTS AND NEW DEVICES:	
CARDIOSPASM, WITH KINKING OF THE ESOPHAGUS FROM KYPHOSIS. <i>By Alexander B. Moore, M.D., and Porter P. Vinson, M.D.</i>	73
A CASE OF PNEUMOCEPHALUS. <i>By N. J. Nessa, M.D.</i>	74
A SIMPLE METHOD OF CARDIOMETRY. <i>By I. S. Trostler, M.D.</i>	75
EDITORIAL:	
THE DIAGNOSIS OF CARDIO-VASCULAR DISEASE. <i>By Don C. Sutton, M.D.</i>	77
A COMMUNICATION TO THE MEMBERS OF THE RADIOLOGICAL SOCIETY OF NORTH AMERICA: SUBJECT—LIBRARY OF FILM STUDIES. <i>By E. W. Rowe, M.D.</i>	78
SECOND ANNUAL MEETING OF AMERICAN ASSOCIATION OF REGISTERED RADIOLOGICAL TECHNICIANS	79
THE NEW ORLEANS MEETING: POST-MEETING CRUISE TO CUBA, HONDURAS, AND CANAL ZONE. <i>By I. S. Trostler, M.D.</i>	80
ADDITIONAL HONORS FOR A MEMBER OF THE SOCIETY.....	81
BOOK REVIEWS	81
ABSTRACTS OF CURRENT LITERATURE.....	82

OFFICERS OF THE RADIOLOGICAL SOCIETY OF NORTH AMERICA

E. W. ROWE, M.D.	<i>President</i>	Lincoln, Nebraska
EDWIN C. ERNST, M.D.	<i>President-elect</i>	St. Louis, Missouri
AMEDEE GRANGER, M.D.	<i>First Vice-president</i>	New Orleans, Louisiana
DONALD S. CHILDS, M.D.	<i>Second Vice-president</i>	Syracuse, New York
WILLIAM E. CHAMBERLAIN, M.D.	<i>Third Vice-president</i>	San Francisco, California
ROBERT J. MAY, M.D.	<i>Secretary-Treasurer</i>	Cleveland, Ohio

COMMITTEES

EXECUTIVE COMMITTEE

ROBERT H. LAFFERTY, M.D., *Chairman*, Charlotte, N. C.
 CLYDE O. DONALDSON, M.D., Lathrop Building, Kansas City, Mo.
 JOHN F. HERRICK, M.D., Hofmann Block, Ottumwa, Iowa
 E. W. ROWE, M.D., First National Bank Bldg., Lincoln, Nebr.
 E. C. ERNST, M.D., Beaumont Medical Bldg., St. Louis, Mo.

BOARD OF CENSORS

ROLLIN H. STEVENS, M.D., *Chairman*, Detroit, Michigan
 ARTHUR W. ERSKINE, M.D., Cedar Rapids, Iowa
 BERTRAM C. CUSHWAY, M.D., Chicago, Illinois

PROGRAM COMMITTEE

ROBERT A. ARENS, M.D., Michael Reese Hospital, Chicago, Illinois
 W. W. BELDEN, M.D., New York Hospital, New York City
 W. E. CHAMBERLAIN, M.D., Stanford University Hospital, San Francisco, Calif.
 A. U. DESJARDINS, M.D., Mayo Clinic, Rochester, Minnesota
 GEORGE W. GRIER, M.D., Jenkins Arcade Building, Pittsburgh, Pa.
 L. J. MENVILLE, M.D., New Hibernia Bank Building, New Orleans, La.
 JOHN W. PIERSON, M.D., 1107 St. Paul Street, Baltimore, Md.
 DOUGLAS QUICK, M.D., 350 Park Avenue, New York City
 LEROY SANTE, M.D., City Hospital, St. Louis, Missouri
 M. C. SOSMAN, M.D., 721 Huntington Avenue, Boston, Massachusetts

ADVISORY PROGRAM COMMITTEE

LOUIS J. CARTER, M.D., Brandon, Manitoba, Canada
 JAMES T. CASE, M.D., Battle Creek Sanatorium, Battle Creek, Michigan
 A. C. CHRISTIE, M.D., 1909 Massachusetts Avenue, Washington, D. C.
 BERTRAM C. CUSHWAY, M.D., 29 East Madison Street, Chicago, Illinois
 ARTHUR W. ERSKINE, M.D., Higley Building, Cedar Rapids, Iowa
 I. SETH HIRSCH, M.D., 11 E. 68th Street, New York City
 LEON T. LEWALD, M.D., 114 E. 54th Street, New York City
 BENJAMIN H. ORNDOFF, M.D., 2551 North Clark Street, Chicago, Illinois
 ALBERT SOILAND, M.D., 1407 S. Hope Street, Los Angeles, California
 ROLLIN H. STEVENS, M.D., 1429 David Whitney Building, Detroit, Michigan
 ALDEN H. WILLIAMS, M.D., 91 Monroe Avenue, Grand Rapids, Michigan

PUBLICATION COMMITTEE

W. W. WATKINS, M.D., *Chairman*, Phoenix, Arizona
 P. F. BUTLER, M.D., Boston, Massachusetts
 ROLLIN H. STEVENS, M.D., Detroit, Michigan

LEGISLATIVE COMMITTEE

L. J. MENVILLE, M.D., *Chairman*, New Orleans, Louisiana
 ROBERT A. ARENS, M.D., Chicago, Illinois

MEMBERS ON BOARD OF AMERICAN REGISTRY OF RADIOLOGICAL TECHNICIANS

LEROY SANTE, M.D., St. Louis, Missouri
B. H. JACKSON, M.D., Scranton, Pennsylvania

COMMITTEE ON RADIOLOGICAL FRAUDS AND IMPROPER PRACTICES

GEORGE M. LANDAU, M.D., *Chairman*, 432 S. Lincoln Street, Chicago, Illinois
F. BISSELL, M.D., 329 La Salle Building, Minneapolis, Minnesota
LLOYD BRYAN, M.D., Butler Building, San Francisco, California

NECROLOGY COMMITTEE

LEON T. LEWALD, M.D., *Chairman*, New York City
C. H. BURGER, M.D., Winnipeg, Manitoba, Canada
BUNDY ALLEN, M.D., Tampa, Florida
R. R. NEWELL, M.D., San Francisco, California
W. W. WASSON, M.D., Denver, Colorado

COMMITTEE ON STANDARDIZATION OF X-RAY MEASUREMENTS

EDWIN C. ERNST, M.D., *Chairman*, St. Louis, Missouri
OTTO GLASSER, Ph.D., New York City
WILHELM STENSTROM, Ph.D., Minneapolis, Minnesota
NOAH ERNEST DORSEY, Ph.D., Washington, D. C.
F. L. HUNT, Ph.D., Washington, D. C.
WILLIAM E. CHAMBERLAIN, M.D., San Francisco, California
ARTHUR W. ERSKINE, M.D., Cedar Rapids, Iowa

COMMITTEE TO INVESTIGATE HOT CATHODE TUBE SITUATION

GERALD D. BLISS, M.D., *Chairman*, Altoona, Pennsylvania
WALTER I. LE FEVRE, M.D., Cleveland, Ohio
DONALD S. CHILDS, M.D., Syracuse, New York

COMMITTEE ON SAFE APPARATUS

E. L. JENKINSON, M.D., *Chairman*, Chicago, Illinois
DALTON RICHARDSON, M.D., Austin, Texas

COMMITTEE ON SCIENTIFIC AWARDS

B. H. NICHOLS, M.D., *Chairman*, Cleveland, Ohio
B. R. KIRKLIN, M.D., Rochester, Minnesota
MAX KAHN, M.D., Baltimore, Maryland

COMMITTEE ON INSURANCE

I. S. TROSTLER, M.D., *Chairman*, Chicago, Illinois
HARVEY W. VAN ALLEN, M.D., Springfield, Massachusetts
HENRY J. ULLMANN, M.D., Santa Barbara, California

LOCAL COMMITTEE ON ARRANGEMENTS

AMEDEE GRANGER, M.D., *Chairman*, New Orleans, Louisiana
ELEAZER R. BOWIE, M.D., New Orleans, Louisiana
L. A. FORTIER, M.D., New Orleans, Louisiana
T. T. GATELY, M.D., New Orleans, Louisiana
L. J. MENVILLE, M.D., New Orleans, Louisiana
ERNEST C. SAMUEL, M.D., New Orleans, Louisiana

LIBRARIAN

CHARLES G. SUTHERLAND, M.B. (Tor.), Rochester, Minn.

MANAGER OF TRANSPORTATION AND COMMERCIAL EXHIBITS

I. S. TROSTLER, M.D., Chicago, Ill.

COUNSELORS

CANADA

Alberta	W. H. MCGUFFIN, M.D.	Calgary
British Columbia	HAMISH H. MCINTOSH, M.D.	Vancouver
Manitoba	J. C. McMILLAN, M.D.	Winnipeg
New Brunswick	ARCHIBALD S. KIRKLAND, M.D.	St. John
Ontario	HERMANN E. SCHAEF, M.D.	London
Quebec	LEO E. PARISEAU, M.D.	Montreal
Saskatchewan	CLARENCE M. HENRY, M.D.	Regina

CUBA

Cuba	FILBERTO RIVERO, M.D.	Havana
----------------	-------------------------------	--------

UNITED STATES

Alabama	JAMES A. MEADOWS, M.D.	Birmingham
Arizona	H. P. MILLS, M.D.	Phoenix
Arkansas	CHARLES H. NIMS, M.D.	Hot Springs
California	ROBERT R. NEWELL, M.D.	San Francisco
Colorado	WILLIAM E. COSTLOW, M.D.	Los Angeles
Connecticut	LEWIS G. BROWN, M.D.	Colorado Springs
Delaware	LOUIS F. WHEATLEY, M.D.	New Haven
District of Columbia	GEORGE C. McELFATRICK, M.D.	Washington
Florida	E. A. MERRITT, M.D.	Washington
Georgia	BUNDY ALLEN, M.D.	Tampa
Idaho	WILLIAM F. LAKE, M.D.	Atlanta
Illinois	CHARLES V. GENOWAY, M.D.	Boise
Indiana	W. T. BRONSON, M.D.	Chicago
Iowa	PERRY B. GOODWIN, M.D.	Peoria
Kansas	L. A. SMITH, M.D.	Indianapolis
Kentucky	L. J. TALLEY, M.D.	Marshalltown
Louisiana	OPIE W. SWOPE, M.D.	Wichita
Maine	CHARLES D. ENFIELD, M.D.	Louisville
Maryland	LEON J. MENVILLE, M.D.	New Orleans
Massachusetts	EDSON S. CUMMINGS, M.D.	Portland
Michigan	JOHN EVANS, M.D.	Baltimore
Minnesota	JOHN D. CAMP, M.D.	Boston
Mississippi	HENRY L. ULBRICH, M.D.	Detroit
Missouri	FRANK BISSELL, M.D.	Minneapolis
Montana	WILLIAM M. RAINOLD, M.D.	Gulfport
Nebraska	PAUL F. TITTERINGTON, M.D.	St. Louis
Nevada	FRED F. ATTIX, M.D.	Lewistown
New Hampshire	ROSCOE L. SMITH, M.D.	Lincoln
New Jersey	C. E. PIERSALL, M.D.	Reno
New Mexico	JOHN D. CAMP, M.D.	Boston, Mass.
New York	CHARLES F. BAKER, M.D.	Newark
North Carolina	JOHN R. VAN ATTA, M.D.	Aubquerque
North Dakota	DONALD S. CHILDS, M.D.	Syracuse
Ohio	ALFRED L. L. BELL, M.D.	New York City
Oklahoma	JOHN D. MACRAE, M.D.	Ashville
Oregon	ALBERT J. CLAY, M.D.	Fargo
Pennsylvania	B. H. NICHOLS, M.D.	Cleveland
Rhode Island	E. R. BABER, M.D.	Cincinnati
South Carolina	MARION M. ROLAND, M.D.	Oklahoma City
South Dakota	ROY A. PAYNE, M.D.	Portland
Tennessee	JOHN F. McCULLOUGH, M.D.	Pittsburgh
Texas	BYRON H. JACKSON, M.D.	Scranton
Utah	ISAAC GERBER, M.D.	Providence
Vermont	FLOYD D. RODGERS, M.D.	Columbia
Virginia	N. J. NESSA, M.D.	Sioux Falls
Washington	STANTON S. MARCHBANKS, M.D.	Chattanooga
West Virginia	RABUN T. WILSON, M.D.	Temple
Wisconsin	GEORGE TURNER, M.D.	El Paso
Wyoming	W. G. McDEED, M.D.	Houston
Army	R. MARK BROWN, M.D.	Ogden
Navy	CLARENCE F. BALL, M.D.	Rutland
	JOSEPH T. MCKINNEY, M.D.	Roanoke
	JOSEPH ASPRAY, M.D.	Spokane
	LONZO O. ROSE, M.D.	Parkersburg
	HARRY B. POBLASKY, M.D.	Milwaukee
	CLYDE Y. BEARD, M.D.	Cheyenne
	Major GEORGE M. EDWARDS, M.D.	Army Medical School.
		Washington, D. C.
	Lt. Com. THOMAS W. RAISON, M.D.	U. S. Naval Hospital
		Canacao, Philippine Is-
		lands

GENERAL INFORMATION

The next Annual Meeting of the Society will be held in New Orleans, La., Nov. 28-Dec. 2, 1927.

RADIOLOGY is published by the Radiological Society of North America, under the supervision of a Publication Committee. This Committee reserves the right to reject any material submitted for publication, including advertisements.

Original articles will be accepted only with the understanding that they are contributed solely to RADIOLOGY. Articles in a foreign language will be translated if acceptable.

Manuscripts should be typewritten, double spaced, with wide margins, on good paper, and the original, not a carbon copy, submitted. It is advisable that the author keep a carbon copy, as used manuscripts will not be returned. The author's full address should appear on the manuscript.

Manuscripts for publication should be forwarded to the Editor, Dr. M. J. Hubeny, 25 East Washington Street, Chicago, Illinois.

Four cuts will be furnished gratis by RADIOLOGY when satisfactory photographs or drawings are supplied by the author. Special arrangements must be made with the Editor for an unusual number of illustrations or tables.

Photographic prints should be clear and distinct and on glossy paper, preferably mounted. Drawings and charts should be in black ink on white paper. All photographs and drawings should be numbered, the top should be indicated, and each should be accompanied by a legend with a corresponding number.

Reprints are furnished on order only, and should be ordered from the Business Manager on returning galley proofs. Prices of reprints will be quoted on request. Discussions will not be included in reprints unless specifically requested.

Rate for "want" advertisements for insertion in Classified Section is 8 cents per word, minimum charge \$2.00. Remittance should accompany order. Rates for display advertisements furnished upon request.

Correspondence relative to subscriptions, advertisements, reprints and other business of RADIOLOGY should be addressed to the Business Manager, J. R. Bruce, 2429 University Avenue, St. Paul, Minnesota.

In requesting a change of address, both the old and the new address should be given.

Information concerning membership in the Radiological Society of North America can be obtained from the President-elect, Dr. Edwin C. Ernst, Humboldt Bldg., St. Louis, Mo.

Inquiries regarding the program of the meetings of the Society for the current year should be sent to the President.

Exhibit space for the meetings is in charge of Dr. I. S. Trostler, 25 East Washington Street, Chicago, Illinois.

The Editor accepts no responsibility for the opinions expressed by the contributors. We endeavor to publish the papers as submitted, reserving the right to introduce such changes as may be necessary to make the contributions conform to our editorial standards.

RADIOLOGY is owned and published by the Radiological Society of North America as its official journal. Subscription rate, \$5.00 per annum. Canadian postage, 25 cents additional; foreign countries 50 cents additional. Single copies, 60 cents each. Remittances should be made payable to the Radiological Society of North America and should be addressed to the Business Manager, 2429 University Avenue, Saint Paul, Minnesota. *Entered at the post office at Saint Paul, Minnesota, as mail matter of the second class at the special rate of postage provided for in Sec. 1103, Act of October 3, 1917, authorized July 1, 1918.*

M. J. HUBENY, M.D., 25 East Washington Street, Chicago, Ill. - - - - - Editor

J. R. BRUCE, 2429 University Avenue, Saint Paul, Minn. - - - - - Business Manager

WILLIAM HEINEMANN (Medical Books), Ltd., 20, Bedford St., London, W. C. 2, England,
London Agents

COUNSELORS

CANADA

Alberta	W. H. McGUFFIN, M.D.	Calgary
British Columbia	HAMISH H. MCINTOSH, M.D.	Vancouver
Manitoba	J. C. McMILLAN, M.D.	Winnipeg
New Brunswick	ARCHIBALD S. KIRKLAND, M.D.	St. John
Ontario	HERMANN E. SCHAEF, M.D.	London
Quebec	LEO E. PARISEAU, M.D.	Montreal
Saskatchewan	CLARENCE M. HENRY, M.D.	Regina

CUBA

Cuba	FILBERTO RIVERO, M.D.	Havana
----------------	-------------------------------	--------

UNITED STATES

Alabama	JAMES A. MEADOWS, M.D.	Birmingham
Arizona	H. P. MILLS, M.D.	Phoenix
Arkansas	CHARLES H. NIMS, M.D.	Hot Springs
California	ROBERT R. NEWELL, M.D.	San Francisco
	WILLIAM E. COSTLOW, M.D.	Los Angeles
Colorado	LEWIS G. BROWN, M.D.	Colorado Springs
Connecticut	LOUIS F. WHEATLEY, M.D.	New Haven
Delaware	GEORGE C. McELPATRICK, M.D.	Wilmington
District of Columbia	E. A. MERRITT, M.D.	Washington
Florida	BUNDY ALLEN, M.D.	Tampa
Georgia	WILLIAM F. LAKE, M.D.	Atlanta
Idaho	CHARLES V. GENOWAY, M.D.	Boise
Illinois	W. T. BRONSON, M.D.	Chicago
	PERRY B. GOODWIN, M.D.	Peoria
Indiana	L. A. SMITH, M.D.	Indianapolis
Iowa	L. J. TALLEY, M.D.	Marshalltown
Kansas	ORIE W. SWOPE, M.D.	Wichita
Kentucky	CHARLES D. ENFIELD, M.D.	Louisville
Louisiana	LEON J. MENVILLE, M.D.	New Orleans
Maine	EDSON S. CUMMINGS, M.D.	Portland
Maryland	JOHN EVANS, M.D.	Baltimore
Massachusetts	JOHN D. CAMP, M.D.	Boston
Michigan	HENRY L. ULBRICH, M.D.	Detroit
Minnesota	FRANK BISSELL, M.D.	Minneapolis
Mississippi	WILLIAM M. RAINOLD, M.D.	Gulfport
Missouri	PAUL F. TITTERINGTON, M.D.	St. Louis
Montana	FRED F. ATTIX, M.D.	Lewistown
Nebraska	ROSCOE L. SMITH, M.D.	Lincoln
Nevada	C. E. PIERSALL, M.D.	Reno
New Hampshire	JOHN D. CAMP, M.D.	Boston, Mass.
New Jersey	CHARLES F. BAKER, M.D.	Newark
New Mexico	JOHN R. VAN ATTA, M.D.	Abuquerque
New York	DONALD S. CHILDS, M.D.	Syracuse
	ALFRED L. L. BELL, M.D.	New York City
North Carolina	JOHN D. MACRAE, M.D.	Asheville
North Dakota	ALBERT J. CLAY, M.D.	Fargo
Ohio	B. H. NICHOLS, M.D.	Cleveland
	E. R. BADER, M.D.	Cincinnati
Oklahoma	MARION M. ROLAND, M.D.	Oklahoma City
Oregon	ROY A. PAYNE, M.D.	Portland
Pennsylvania	JOHN F. McCULLOUGH, M.D.	Pittsburgh
	BYRON H. JACKSON, M.D.	Scranton
Rhode Island	ISAAC GERBER, M.D.	Providence
South Carolina	FLOYD D. RODGERS, M.D.	Columbia
South Dakota	N. J. NESSA, M.D.	Sioux Falls
Tennessee	STANTON S. MARCHBANKS, M.D.	Chattanooga
Texas	RABUN T. WILSON, M.D.	Temple
	GEORGE TURNER, M.D.	El Paso
	W. G. McDEED, M.D.	Houston
Utah	R. MARK BROWN, M.D.	Ogden
Vermont	CLARENCE F. BALL, M.D.	Rutland
Virginia	JOSEPH T. MCKINNEY, M.D.	Roanoke
Washington	JOSEPH ASPRAY, M.D.	Spokane
West Virginia	LONZO O. ROSE, M.D.	Parkersburg
Wisconsin	HARRY B. PODLASKY, M.D.	Milwaukee
Wyoming	CLYDE Y. BEARD, M.D.	Cheyenne
Army	Major GEORGE M. EDWARDS, M.D.	Army Medical School, Washington, D. C.
Navy	Lt. Com. THOMAS W. RAISON, M.D.	U. S. Naval Hospital Canacao, Philippine Is- lands

RADIOLOGY

A MONTHLY JOURNAL DEVOTED TO CLINICAL RADIOLOGY AND ALLIED SCIENCES

PUBLISHED BY THE RADIOLOGICAL SOCIETY OF NORTH AMERICA

VOL. IX

JULY, 1927

No. 1

CHRONIC OBSTRUCTION OF THE SMALL INTESTINE¹

By JAMES T. CASE, M.D., F.A.C.S., D.M.R.E. (Cambridge)

Battle Creek Sanitarium, BATTLE CREEK, MICHIGAN

THE literature is filled with accurate and, we may say, classical descriptions of the X-ray findings in duodenal ulcer and its differential diagnosis. Less accurate, and certainly less in agreement are the findings and their interpretation in conditions involving the second and third portions of the duodenum and the remainder of the small bowel. A great deal of controversy has arisen as to the conditions called chronic duodenal ileus and chronic ileal stasis—stagnation of opaque material in the duodenum and in the terminal portion of the ileum. There is such a large personal factor obviously present in the interpretations that one is almost bewildered by the divergent opinions voiced.

There is a clear field of agreement and obvious sound sense in interpreting the findings of the opaque meal study in cases of congenital or neoplastic obstruction of the duodenum or remaining small bowel,—indeed, with any kind of obstruction where there is evident blocking of the lumen of the bowel, with accumulation of opaque mass above the stricture in what is evidently dilated lumen, and lack of opaque mass, or at least scarcity of it, below the stenosis. The

difficulties arise in those borderline conditions verging on purely functional disturbances, for such may be called many cases of stasis in the duodenum or terminal ileum.

Illustrating some of the statements just recorded may be cited a recent paper by Wheelon (1) in which we find the statement that duodenal retention and reverse motility—passage of barium toward the pylorus—were observed radiologically in seventy-four of a series of seventy-seven patients who came to surgery for the correction of pathologic changes within the abdomen. If the author's observations are correct, it is evident that reversal of motility in the duodenum is by no means an unusual finding. One would certainly be tempted to draw the conclusion that no very great reliance could be placed upon duodenal antiperistalsis as an indicator of serious duodenal or upper jejunal pathology. On the other hand, Schwarz (2), of Vienna, declares that retrograde transport of duodenal contents is seen only in true stasis, and in its most characteristic form in deep duodenal stenosis. Schwarz especially calls attention to the type of broad contraction ring which sweeps before it a considerable mass of duodenal content, and then returns it in the retrograde direction in a manner analogous to the to-

¹Presented before the Radiological Society of North America, at the Twelfth Annual Meeting, at Milwaukee, Nov. 29-Dec. 4, 1926.

and-fro movement of opaque material in the esophagus above a stricture.

NORMAL DUODENAL MOTOR BEHAVIOR

The writer (3) in 1915, before the American Roentgen Ray Society, described the

during suspended respiration. Although in obstruction of the duodenum one should look for and expect to find reverse duodenal peristalsis, this retrograde duodenal transport is not necessarily pathognomonic of organic obstruction. It may be easily produced by

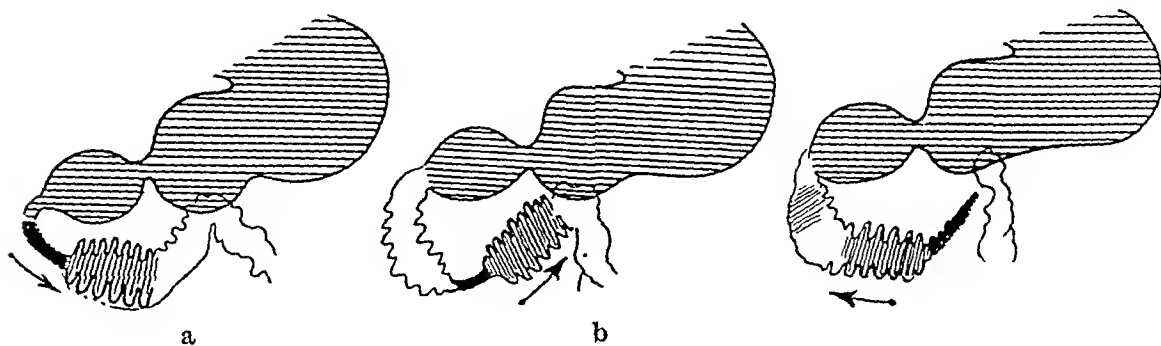


Fig. 1. Illustrating reverse peristalsis in the duodenum. (After Schwarz.)

motor behavior of the duodenum in the following words: "At irregular intervals, depending upon the mechanism which controls the opening of the pylorus, the duodenal bulb contracts, the contraction appearing about two centimeters beyond the pylorus. This contraction is occasionally seen to begin at the pylorus itself. This contraction in the bulb occurs when an antrum contraction is nearing the pylorus, usually when the antrum contraction wave is about three centimeters from the pylorus. Serial radiograms, according to the method of Kaestle, further developed by Pirie, Cole, George, and Gerber, will demonstrate beautifully the nature of this duodenal bulb contraction. It is a ring contraction wave which carries a bolus of material usually the entire length of the duodenum past the duodenal junction."

Were one to depend solely upon film records, the appearance of barium recorded at certain moments in connection with one of these ring contraction waves might lead to an erroneous diagnosis of duodenal obstruction. It was the writer's opinion at that time that one frequently sees reverse peristalsis in the duodenum, independently of respiration, as may be proved by studies

compressing the duodeno-jejunal junction between the palpating hand and the spine, thus producing a temporary obstruction; and it is also possible to observe such antiperistalsis when an emaciated patient is lying upon the back and the duodenum is compressed by saddling across the spine.

DUODENAL STASIS

Kinking at the duodeno-jejunal flexure has been advanced as a common cause of chronic duodenal stasis (Lane, and numerous others). Some have added the factors of ptosis of the third portion of the duodenum (abnormal fixation according to others), of drag of the mesentery across the third portion of the duodenum, renal prolapse, ileocecal prolapse. Whatever truth there may be in any or all of the above (and undoubtedly they all occur), the fact remains that if we are to develop radiologic diagnosis of duodenal obstruction in a safe, sane, and reliable manner, we must recognize that from the radiologic examination alone we derive one important sign, *viz.*, the proof or lack of proof of stasis. Again, let us be reminded that the so-called "writhing duodenum," believed by some to

be pathognomonic of duodenal obstruction, is demonstrable in almost every thin patient when examined in the supine position and with the unusually large amounts of barium recommended by Jordan and others;

tainable with the patient in any position, taking care not to mistake unusual filling of the duodenum as necessarily or even probably indicating duodenal obstruction, remembering (let it be repeated once more)

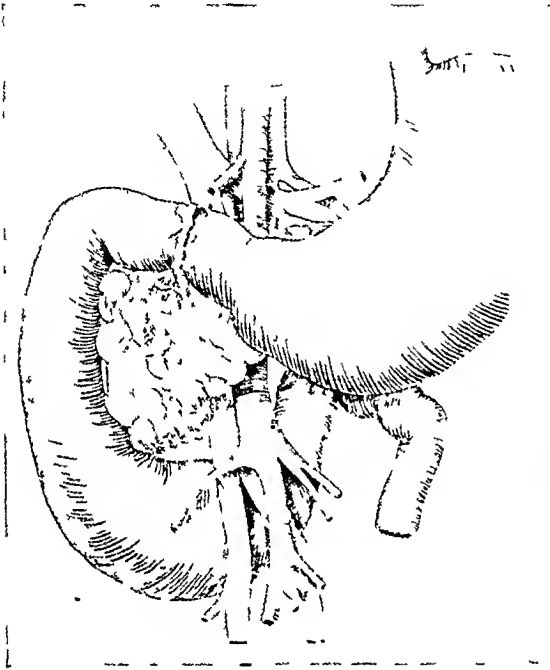


Fig 2 Illustrating ileus of the third portion of the duodenum from pressure of the superior mesenteric vessels (Adams)

that we must employ the fluoroscope in studying intestinal peristalsis if we would avoid error; that a true duodenal obstruction should be demonstrable on repeated examination and should seriously interfere with the passage of material past the seat of hindrance. Many cases of so-called "writhing duodenum" supposed to be due to duodeno-jejunal region obstruction, exhibit also early filling of the upper small bowel and such extensive and uniform distribution of barium throughout the entire small intestine, with clearance of both stomach and duodenum within the normal time, that one cannot entertain the idea of obstruction. With an organic obstruction of the duodenum the characteristic signs should be ob-



Fig 3 Chronic duodenal ileus associated with duodenal ulcer

that apparent duodenal dilatation may result from examination of the supine patient, for in this position the duodenum saddles over the spine in such a way as to make a certain degree of obstruction at the duodeno-jejunal flexure, with writhing duodenal movements. Unusual visualization of the duodenum may also result from too rapid delivery of the gastric contents into the duodenum through pyloric insufficiency. This insufficiency may be associated with achylia or duodenal ulcer or with pancreatic disease which has not yet reached the stage where by its mass or by actual extension



Fig. 4. Chronic duodenal ileus associated with duodenal ulcer.

onto the duodenum it causes organic obstruction. When the duodenum is unusually filled, one rules out organic obstruction if there is free filling of the first portion of the jejunum. If the patient has been resting upon the right side for a while preceding the fluoroscopic study or before the film records, one is likely to find the duodenum unusually filled.

From the above discussion it would appear that the only radiologic proof of duodenal stasis is the demonstration of a prolongation in the emptying time of the duodenum, indirect evidences being writhing of the duodenum, retrograde transport of duodenal contents, duodenal dilatation, care being taken to differentiate and rule out the causes of error above related.

As to the cause of the stasis, little more information is available from the radiologist unless he takes into account facts obtainable from the history. In a young infant, a congenital obstruction should be suspected, though some writers attribute certain cases of duodenal stasis occurring in later life to congenital hepato-duodenal and hepato-colic bands which give no trouble until the third



Fig. 5. Chronic duodenal ileus associated with duodenal ulcer. (See Fig 6.)

or fourth decade of life. Following an operation, one must carefully study to differentiate an obstruction the result of post-operative adhesions and an obstruction which existed before the operation and in the treatment of which an operative failure must be recorded, usually on account of a wrong diagnosis. There is a fairly large group of cases where duodenal obstruction with symptoms mainly of a gastric nature follows a gall-bladder operation, especially where a cholecystostomy was done rather than a cholecystectomy; the former operation is more likely to be followed by extensive post-operative adhesions which must involve the duodenum.

In certain cases, from the radiologic findings alone, it is possible to state the cause of the obstruction: A carcinoma of the stomach may be apparent, along with evidence of duodenal stasis, in which instance

it is reasonable to state that the obstruction is probably due to extension of the carcinoma, especially on the posterior wall, with involvement of the duodeno-jejunal junction. There may be an ulcer of the stomach, especially on the posterior wall, or even of the duodenum, with secondary adhesions involving the duodenum. The distal end of the shadow of the dilated or obstructed duodenum may exhibit characteristic filling defects suggesting primary malignant disease of the duodenum. A serrated outline of the narrowed persisting duodenal shadow (normally the duodenal shadow is never persistently seen beyond the first portion) would indicate malignant disease extending from the pancreas, the liver, the kidney or colon, the particular one being suggested by other radiologic findings or by the direction of displacement of the duodenal shadow. A pancreatic tumor usually spreads out the shadow of the duodenum so that it describes a larger curve than usual.

Diverticula of the duodenum rather rarely cause obstruction, but their presence should not escape a careful fluoroscopic study, with palpation of the abdomen under the fluoroscopic screen. When diverticulitis is present, implying by this term inflammatory changes in or about the sac, then the associated adhesions or induration may cause obstruction. The majority of our cases of duodenal diverticula did not cause obstruction of the duodenum.

DUODENAL STENOSIS

Duodenal stenosis may be considered under three heads: supra-ampullary, ampullary, and infra-ampullary.

In supra-ampullary duodenal obstruction, clinically no bile is found in the stomach contents, and roentgenologically the findings are very likely to suggest a duodenal stenosis of the type ordinarily produced by duodenal ulcer. The symptoms generally, both clinical and roentgenological, are gastric



Fig 6 The residue in the dilated duodenum after completion of gastric evacuation (See Fig. 5)

rather than duodenal; sometimes it is impossible to elicit any roentgen sign to differentiate such an obstruction from a pyloric stenosis. The lesions to be differentiated are the ones which commonly have to be considered and excluded in making a diagnosis of duodenal ulcer with obstruction. A primary carcinoma of the duodenum is extremely rare. Extension of malignant disease from the pancreas or liver or gall bladder, periduodenal adhesions from gall-bladder disease or following gall-bladder operation are among the important pathological states to be thought of. The presence or absence of jaundice may assist in the diagnosis. The writer had one case of supra-ampullary-duodenal obstruction due to impaction of a large gallstone which had found its way into the stomach through spontaneous cholecystogastrostomy.

Ampullary obstructions of the duodenum are usually associated with jaundice and



Figs. 7 (upper left), 8 (upper right), 9 (lower left), and 10 (lower right). Chronic duodenal obstruction due to carcinoma of pancreas infiltrating connective tissue in region of duodeno-jejunal flexure. Arrows point to duodenum. Note the different shapes of the duodenum observed at various times during duodenal contractions. The shape illustrated in Figure 9 was associated with spasms of intense abdominal pain.

with disease of the biliary tract. The roentgen findings are similar to those of supra-ampullary stenosis. Cholecystography may be helpful in this type of obstruction.

Infra-ampullary obstruction (deep duodenal stenosis), clinically characterized in most instances by the presence of bile in the stomach contents, may be due to any one of a long list of causes, among which the following may be mentioned: metastatic

carcinomatous glands near the mesenteric root; adhesion of high jejunal loops to the anterior abdominal wall following peritonitis; fixation of the duodeno-jejunal flexure; paraduodenal hernia; hernia of the diaphragm; pericecal adhesions, appendix being attached by inflammation to the root of the mesentery; carcinoma of the pancreas infiltrating the root of the mesentery and duodenum; gastric ulcer with the inflam-



Fig 11. Primary carcinoma of the ileum

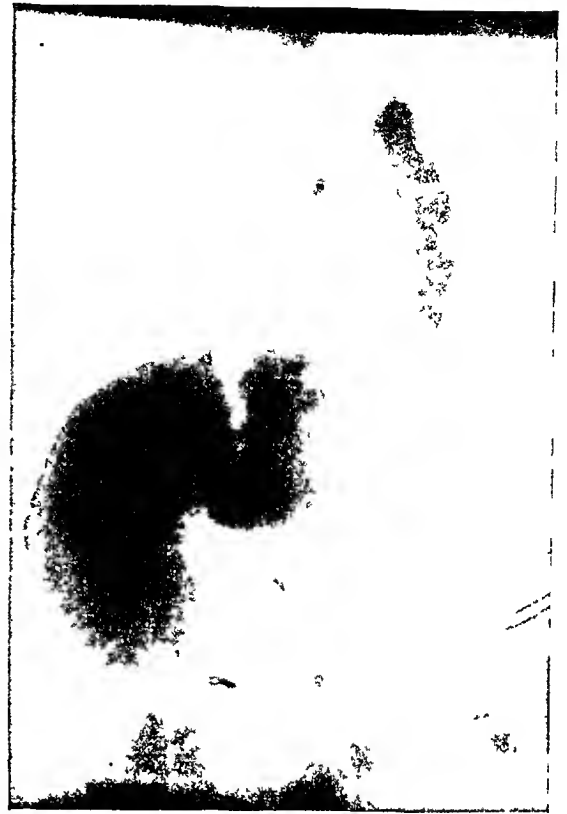


Fig. 12 Extensive carcinoma of the stomach with infiltration to duodeno-jejunal flexure causing high-grade duodenal obstruction

matory process drawing up and kinking the duodeno-jejunal flexure; chronic arterio-mesenteric obstruction of the duodenum.

It is a notable fact that in many cases of gastric or duodenal ulcer there is to be observed behind the stomach an inflammatory lesion resulting in one or more adhesion bands involving the duodeno-jejunal flexure. In our cases a common cause has been malignant disease of the pancreas or stomach, with associated malignant or inflammatory infiltration of the retroperitoneal connective tissue around the root of the mesentery or duodenum, causing fixation of the duodeno-jejunal junction.

In benign cases there is frequently a combination of pressure of the superior mesenteric artery and of the root of the mesentery plus the drag of intestinal loops on the mesenteric root, making obstruction at the flexure. Experimental observations made by Albrecht, Melchior and others (4) seem to show that a pull of one and one-half to

two kilograms may be developed by intestinal coils dragging on the mesenteric root. Brin and Denechau cite an interesting case in which there was the added factor of atheroma of the superior mesenteric artery and a considerable augmentation of size of the mesenteric root. Bloodgood has suggested that the cecum when enlarged and prolapsed down into the pelvis may play a part in stretching the mesentery. In other cases at operation one may note the high position of the spinal column with the proximal part of the mesentery presenting, tightly stretched over the spine, and with the small intestine hanging down not so much toward the pelvis as in the direction of the two lumbar grooves created by the projecting spinal column; the jejunum is seen to be collapsed while the duodenum is dilated.

Among the above-named causes of chron-



Fig. 13. High-grade duodenal obstruction and gastric delay associated with carcinoma of the duodenum

ic duodenal obstruction was mentioned fixation of the duodeno-jejunal flexure. It was generally accepted that the duodeno-jejunal flexure should be more or less mobile. When fixation occurs as the result of cicatricial bands following gastric or duodenal ulcers or as a result of infiltration from inflammatory or malignant processes in the vicinity, duodenal stagnation and dilatation are apt to occur.

At times there may appear to be a marked variation in the position of the duodeno-jejunal flexure as related to the position of the lower border of the stomach, but it is self-evident that this variation is in reality one which has to do with the changing position of the lower border of the stomach incident to filling and emptying rather than to any change in the position of the flexure.

During the roentgen examination we observed the following in cases of chronic duodenal stasis:

When the rapid movement of the barium toward the jejunum begins, it is thrown back to the duodenal bulb by a powerful antiperistaltic contraction. In the meantime, as a result of the gradual filling of the



Fig. 14. High-grade duodenal obstruction due to infiltration from carcinoma of pancreas

third portion of the duodenum, a peculiar shadow, with convexity downward, develops, which becomes larger and larger as the former movement is repeated. From time to time it is seen that some portions pass into the jejunum. At times the horizontal portion of the duodenum which has now become filled loses its serrated contour and becomes perfectly smooth in outline; then again, during periods of violent contraction, marked serrations occur. Complete evacuation of the dilated third portion of the duodenum usually requires a little longer than the time for emptying the stomach, and sometimes much longer, even up to twenty-four hours.

In obstructions due to invasion of the duodenum by extra-duodenal lesions, such as carcinoma of the pancreas and retroperitoneal neoplasms, there is to



Fig. 15. Chronic small intestinal obstruction, post-operative, due to adhesions of small bowel to anterior abdominal wall in region of old suprapubic scar.



Fig. 16. Roentgenogram made 4½ hours after meal in the case of Mrs. W, referred to in text. No evident abnormality of small intestine. Only very moderate ileac delay.

an irregularity of the border of the duodenal shadow which is highly suggestive of such neoplastic invasion (Fig. 14).

From the degree of duodenal dilatation one may be justified in attempting to draw an inference as to the nature of the obstructing lesion. For instance, just as in the esophagus, long standing, benign progressive lesions may permit very marked dilatation as contrasted with the relatively slight enlargement attending malignant obstructive lesions, so in duodenal obstructions, the greatest dilatations are noted with tuberculous or other benign obstructions, rather than with malignant types of hindrance which are of relatively much shorter duration. In a tuberculous stricture high in the jejunum or near the duodeno-jejunal junction the slowly and progressively developing obstruction may lead to a duodenal dilatation of enormous size, the distended

duodenum sinking low down retroperitoneally on account of its great size and weight. In such a case the factors causing the obstruction are not only the primary stricture, but later a pull developed from the distended duodenum accentuates the drag on the mesenteric root, still further developing the obstruction.

Note should be made also that duodenal stenosis is not always persistent. There are types of intermittent duodenal stenosis in which a roentgen examination made at a time when the stenosis is not active may fail to show any signs of obstruction. One might think this group of cases associated principally with gastropnoia, the mesentery being elongated; but even organic and permanent lesions of the duodenum may produce obstruction of the intermittent type and be discoverable roentgenologically only if one happens to be making the examina-



Fig 17 Same case as Figure 16, two weeks later, after patient had developed acute small intestinal obstruction

tion during an acute exacerbation. This we have noted repeatedly in chronic ileal obstructions, especially those associated with post-operative adhesions. The intermittent character of the symptoms may be explained by the fact that the stenosis is often only relative. According to Nesbit (5), a partial duodenal obstruction can be demonstrated in a large proportion of cases of dyspeptic symptoms.

The pain in chronic duodenal obstruction is usually localized at the umbilicus or near it, occurring in cramps or temporary spasms of pain, usually with intervals of relative freedom. These spasms occur from half an hour to an hour following meals and sometimes are associated with upper abdominal distention. In one case the enlarged duodenum was mistaken for a distended gall bladder. During these spasms of almost

unendurable pain the patient may turn pale and break out in a cold sweat, exhibiting symptoms to make one think of a perforation. These spasms of pain may last from fifteen to thirty minutes.

In palpating for a point painful on pressure in relation to the duodenum, one should recognize that in many cases of chronic duodenal ileus the third portion of the duodenum has developed a dilatation downward in the loose connective tissue behind the peritoneum well toward the true pelvis, and that palpation over the duodenum in such cases should be made much lower than usual in the abdomen.

JEJUNO-ILEAL MOTOR PHYSIOLOGY

In the jejunum and ileum we observe roentgenologically four types of peristaltic movements:

(a) A pendulum movement, which is assumed to be brought about by local irritation of the intestinal wall, and which is known to bring about an admixture, kneading, pressing, rolling and pushing together of the intestinal contents without causing any considerable change in its location.

(b) Rhythmical segmental movements characterized ordinarily by the formation of large, jagged indentations. This movement is ordinarily limited to the ileum and does not begin until three hours after eating. It assembles and inspissates the intestinal contents, preparing them for absorption.

(c) True peristaltic, or forwarding peristaltic movements, which take place without any considerable shifting of the intestinal wall, are brought about by the mechanical and chemical stimulation of the food and by thermic and psychic influences. Through this movement there is a periodical pushing forward of the intestinal contents distalward as the result of stimulation and contraction above and of relaxation and dilatation below the segment in which the move-



Fig 18 Roentgenogram made 8½ hours after meal, showing ileum containing only a very few traces of the opaque meal (See Fig 19)



Fig 19 Same case as Figure 18, 18 hours later. Regurgitation of ingested food through an incompetent ileocecal valve

ment occurs. A peristaltic movement of this sort is rarely seen on a roentgenogram, but we recognize its results in changes of position of opaque mass. On the fluoroscopic screen such movements are easily followed, sometimes for long distances. This true peristaltic or rapid forward movement is usually much more pronounced in the jejunum where the opaque materials are carried forward rather quickly.

(d) Division and distribution movements, recently described by Rieder (6), occur chiefly in the ileum and probably supplement the rolling-out movement of the rhythmical segmentation, with the formation of masses or clumps of opaque materials which may divide into various sized groups and again coalesce, repeating the process until the ileum is emptied.

Kerkring's folds, which play an important part in some of these movements, are

recognizable in the roentgenogram by the typical feathery appearance of distended jejunal loops, and to a much less degree in the ileum. There are also inconstant folds of mucous membrane which tend to prevent a too rapid forward movement of the intestinal contents. These folds are only scantily developed in the ileum.

In interpreting pathological conditions of the jejuno-ileum, important help can be derived from a study of the published works of Alvarez and of the late Walter Mills. There is an important relation between the rate and manner of peristalsis in the small intestine and chronic colonic stasis. It is wise to recall some of the principles laid down by Mills (7) in his classical paper on the subject of abnormal small intestinal states:

"When there is an organic alimentary obstruction there will be dilatation and motor



Fig 17 Same case as Figure 16, two weeks later, after patient had developed acute small intestinal obstruction

tion during an acute exacerbation. This we have noted repeatedly in chronic ileal obstructions, especially those associated with post-operative adhesions. The intermittent character of the symptoms may be explained by the fact that the stenosis is often only relative. According to Nesbit (5), a partial duodenal obstruction can be demonstrated in a large proportion of cases of dyspeptic symptoms.

The pain in chronic duodenal obstruction is usually localized at the umbilicus or near it, occurring in cramps or temporary spasms of pain, usually with intervals of relative freedom. These spasms occur from half an hour to an hour following meals and sometimes are associated with upper abdominal distention. In one case the enlarged duodenum was mistaken for a distended gall bladder. During these spasms of almost

unendurable pain the patient may turn pale and break out in a cold sweat, exhibiting symptoms to make one think of a perforation. These spasms of pain may last from fifteen to thirty minutes.

In palpating for a point painful on pressure in relation to the duodenum, one should recognize that in many cases of chronic duodenal ileus the third portion of the duodenum has developed a dilatation downward in the loose connective tissue behind the peritoneum well toward the true pelvis, and that palpation over the duodenum in such cases should be made much lower than usual in the abdomen.

JEJUNO-ILEAL MOTOR PHYSIOLOGY

In the jejunum and ileum we observe roentgenologically four types of peristaltic movements:

(a) A pendulum movement, which is assumed to be brought about by local irritation of the intestinal wall, and which is known to bring about an admixture, kneading, pressing, rolling and pushing together of the intestinal contents without causing any considerable change in its location.

(b) Rhythmical segmental movements characterized ordinarily by the formation of large, jagged indentations. This movement is ordinarily limited to the ileum and does not begin until three hours after eating. It assembles and inspissates the intestinal contents, preparing them for absorption.

(c) True peristaltic, or forwarding peristaltic movements, which take place without any considerable shifting of the intestinal wall, are brought about by the mechanical and chemical stimulation of the food and by thermic and psychic influences. Through this movement there is a periodical pushing forward of the intestinal contents distalward as the result of stimulation and contraction above and of relaxation and dilatation below the segment in which the move-



Fig 18 Roentgenogram made 8½ hours after meal, showing ileum containing only a very few traces of the opaque meal (See Fig 19)



Fig 19 Same case as Figure 18, 18 hours later. Regurgitation of ingested food through an incompetent ileocecal valve

ment occurs. A peristaltic movement of this sort is rarely seen on a roentgenogram, but we recognize its results in changes of position of opaque mass. On the fluoroscopic screen such movements are easily followed, sometimes for long distances. This true peristaltic or rapid forward movement is usually much more pronounced in the jejunum where the opaque materials are carried forward rather quickly.

(d) Division and distribution movements, recently described by Rieder (6), occur chiefly in the ileum and probably supplement the rolling-out movement of the rhythmical segmentation, with the formation of masses or clumps of opaque materials which may divide into various sized groups and again coalesce, repeating the process until the ileum is emptied.

Kerkring's folds, which play an important part in some of these movements, are

recognizable in the roentgenogram by the typical feathery appearance of distended jejunal loops, and to a much less degree in the ileum. There are also inconstant folds of mucous membrane which tend to prevent a too rapid forward movement of the intestinal contents. These folds are only scantily developed in the ileum.

In interpreting pathological conditions of the jejuno-ileum, important help can be derived from a study of the published works of Alvarez and of the late Walter Mills. There is an important relation between the rate and manner of peristalsis in the small intestine and chronic colonic stasis. It is wise to recall some of the principles laid down by Mills (7) in his classical paper on the subject of abnormal small intestinal states:

"When there is an organic alimentary obstruction there will be dilatation and motor

delay proximal to it, their degree being determined by that of the obstruction and the resulting proximal dilatation or hypertrophy. This same far-reaching proximal recoil occurs in a somewhat less degree in functional obstruction of the bowels, as, for instance, marked colonic constipation. Any acquired local lack of resilience in the wall of the intestine, as from an inflammatory or other pathological condition, will lead to recoil and relative proximal stasis. Lesions lessening the recoil-absorbing power of at least certain proximal portions of the alimentary tract determine a greater motility distal to it."

NORMAL AND PATHOLOGICAL MOTILITY IN JEJUNO-ILEUM

Normally the head of the barium column makes an uninterrupted transit from the duodeno-jejunal flexure to the ileocecal valve; that is, excepting for occasional short delays, the first bolus of the barium passed through the duodenum normally continues without a definite arrest until it reaches the last ileal loop leading a train of boluses of opaque material through the small intestine which gradually accumulate in the terminal ileum before passing on into the cecum. There is usually a "puddle" of barium in the terminal ileum even after the cecum has begun to fill.

When for any reason this procession of opaque materials is arrested at a point proximal to the terminal ileal loop, this fact should immediately arouse suspicion of an organic obstruction. If the small intestine proximal to the point of arrest shows a definite dilatation, it suggests at once that the obstruction is exhibiting an acute or subacute exacerbation. Widely dilated loops of jejunum or ileum exhibiting the feathery contours characteristic of small intestine are always indications for surgical interference. There is usually nothing in

the X-ray appearance of these loops which is characteristic of the cause of the hindrance resulting in the obstruction and from which we may draw an inference as to the nature of the obstruction. In a few cases of obstruction high in the jejunum the writer has been able to delineate an irregularity of the bowel shadow just above the stricture, characteristic of a cauliflower growth. In obstruction due to diverticulum of the jejunum or ileum, we are occasionally able to recognize the sacculatation. Generally, however, it is necessary to draw upon the history and the physical examination to determine the nature of the cause of the obstruction. Here, again, as mentioned earlier in the paper, it is evident that we must recognize that the principal value of the X-ray lies in the determination of the fact of the obstruction and its location. An obstructing Lane's kink or obstruction in relation to the appendix may be suspected when the hindrance is located in proximity to the ileocecal valve. A gallstone impaction may be suspected following a severe attack of biliary colic. Multiple small intestine adhesions are frequently associated with a chronic salpingitis, degenerating cystic or fibroid growth, or other inflammatory pelvic disease. A primary intra-intestinal growth, benign or malignant, can only be suspected in cases where careful interrogation of the patient and physical examination seem to exclude other possible causes.

POST-OPERATIVE ADHESIONS

Very often a chronic small intestine obstruction is found following operation, either as a complication of the operation itself or associated with some inflammatory lesion for which the operation was performed. It is a disconcerting fact that frequently in cases following surgical operation where immediately after the operative procedure the patients develop crises of in-

testinal distress, coming on intermittently, which had not existed prior to the operation, careful roentgen observations fail to give the usual decisive evidence of obstruction unless we happen to make the examination at a time when the obstructive lesion is active.

This is well illustrated by Figs. 16 and 17 of Mrs. W. (194-561), 34, who suffered an acute appendicitis at 16 years. At 18, nausea and vomiting commenced. Removal of right ovarian cyst at 20. Ulcer of stomach was suspected but at operation none was found, but vomiting became less frequent, but still continued until she applied for examination. Five years ago complete hysterectomy for relief of uterine hemorrhages. Three years ago the nausea and vomiting again became very frequent, often accompanied by diarrhea and anemia. Prolonged rest in bed improved the condition. Two years ago a repetition of this experience. In the interim only relative freedom from nausea and vomiting. A year ago the patient went through a well-known clinic where her trouble was thought to be congenital. Weight now 25 pounds below normal.

Roentgen examination on Feb. 19, 1927, showed no sign of small intestine disturbance or definite hindrance, the barium meal passing through the small intestine in a perfectly regular manner, all of it having entered the colon before the twelfth hour. No more delay in the terminal ileum was observed than is seen in several cases every day in our work. The patient was put on a rest régime and made excellent progress until, on March 7, there occurred symptoms of an acute obstruction of the bowels. The patient had been placed on duodenal feeding for several days before this so a barium suspension was passed through the tube, and soon the upper small bowel was visualized. Roentgenograms made two or three hours after the introduction of the opaque sus-

pension furnished decisive evidence of the need of immediate operative interference. A temporary ileostomy was done, and later a laparotomy which revealed most extensive adhesions of the small intestine to abdominal wall, pelvic scars and stumps of broad ligaments. Scarcely a foot of small bowel was left unadherent. It was strikingly evident in this case that the roentgen study with the opaque meal showed the chronic obstruction only when it became acute. Here was one of the instances in which a pneumoperitoneum would have revealed the trouble; yet even the introduction of the needle would have been hazardous in this case on account of the universal adhesions; and furthermore, the need of the pneumoperitoneum was not suspected until the obstruction supervened.

In every case of post-operative, post-appendiceal, or post-salpingitic abdominal distress, one should suspect chronic obstruction due to adhesions, whether or not the barium meal shows abnormal small intestine motility or fixation.

ILEOCECAL VALVE INCOMPETENCY

The writer has not given any space here to the discussion of ileocecal valve incompetency in its relation to chronic ileac delay. With J. H. Kellogg, he has written various papers on this subject, the worth of which we have been waiting for time to determine. It may be argued that ileocecal valve incompetency is so common that it is not worth noting. So is constipation, in some degree or other, a common, if not a universal, symptom. We have always felt that ileocecal valve incompetency was a result rather than a cause of pathology, but that it served to complete a vicious circle, more marked constipation producing more marked incompetency and more marked incompetency permitting more marked ileac delay. Constipation exists in many cases as a symp-

tom scarcely noticed by the patient, if, indeed, recognized by him at all. In other instances, it is of such great importance that surgery must be considered for its relief; and there are all the variations between these two extremes. Surely constipation is by no means a negligible symptom, however slight it may seem to the patient. Similarly, it may be argued regarding ileocecal valve incompetency. We hope to publish soon a further study on this interesting question. However, we may add that it has been nine years since we have done an operation for repair of the ileocecal valve for it has seemed more important to hasten the intestinal transit than to operate upon a symptom. It has been further argued that the enema test of ileocecal valve incompetency is not of great importance. We too have wondered regarding this point; but surely no one can argue against the test with the barium meal. If one sees, eight and a half hours following a meal, that the ileum is empty or contains only a very few traces of the opaque meal (Fig. 18), and if, the following morning, eighteen to twenty

hours later, we see definitely two or three feet of ileum (Fig. 19) filled with opaque material, the patient having taken no more barium since the opaque meal of the morning before, certainly the conclusion is warranted that there has occurred a regurgitation of ingested food through an incompetent ileocecal valve.

REFERENCES

1. WHEELON, H.: Symptoms associated with duodenal retention and reverse motility. *Jour. Am. Med. Assn.*, Jan. 30, 1926, LXXXVI, 326.
2. SCHWARZ, G.: Schittenhelm's *Lehrbuch der Röntgendiagnostik*, Berlin, Bd. 2: 854, 1924.
3. CASE, JAMES T.: Roentgen observations on the duodenum, with special reference to lesions beyond the first portion. *Am. Jour. Roentgenol.*, June, 1916, III, 314.
4. ALBRECHT, MELCHIOR and others quoted by BAKAY, L.: Disturbances of passage of the duodenum. *Arch. d. klin. Chir.*, 1926, CXLI, 109-128.
5. NESBIT, G. E.: Partial duodenal obstruction. *Irish Jour. Med. Sc.*, April, 1924, V, 147.
6. RIEDER, H.: The physiological movements of the small intestine in man. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, June, 1925, XXXIII, 461.
7. MILLS, R. WALTER: Some abnormal intestinal states. *Am. Jour. Roentgenol. and Rad. Ther.*, April, 1922, IX, 199.

CHRONIC OBSTRUCTION OF THE DUODENUM¹

By JOSEPH C. BELL, M.D., J. PAUL KEITH, M.D., and D. Y. KEITH, M.D.,
LOUISVILLE, KENTUCKY

RAPID strides have been made in recent years in the diagnosis and treatment of diseases of the gastro-intestinal tract. The introduction of the roentgen ray as an aid in diagnosis has had an important part in this advance, and the rôle of the roentgenologist has become one of increasing importance and one carrying with it considerable responsibility.

The clinical and roentgen-ray findings in gall-bladder disease, peptic ulcer, carcinoma of the various parts of the gastro-intestinal tract, together with many of the less common conditions, such as syphilis of the stomach, tumors outside the gastro-intestinal tract, etc., are universally recognized. But there remains a relatively large group of patients who suffer from chronic gastro-intestinal symptoms at times as serious in their effects as almost any of the above conditions, but in whom no evidence of what is commonly known as organic pathology is to be found. There may be many causes for these symptoms but in a portion of the cases the symptoms are unquestionably due to chronic obstruction of the duodenum.

Obstruction of the duodenum resulting from ulcer, cancer, abnormalities in the pancreas, tumors in adjacent structures, congenital stenosis of the duodenum and impacted gallstones are all generally recognized entities and will not be considered in this paper, but attention will be drawn to obstruction resulting from abnormal bands or adhesions about the duodenum, from kinks in the structure itself or at its junction with the jejunum, and from pressure of the root of the mesentery or the superior mesenteric artery on the transverse portion.

The anatomy of the duodenum is too well

known to require reviewing. The embryological development is also well known, but it may be well to recall that in early embryonic life the duodenum is suspended by both a dorsal and a ventral mesentery. With the growth of the fetus the duodenum increases in length and is displaced to the right, where it eventually occupies the position found in adult life. The caudal three-fourths then adheres to the posterior parietal peritoneum and fuses with it, becoming, in effect, retroperitoneal. The bulb, or first portion, remains surrounded by peritoneum and as a result is much less firmly fixed. After this takes place, in normal cases the anterior mesentery entirely disappears. However, at times portions of the caudal edge may persist as a band or bands extending from the cystic duct, the gall bladder, or both, to the first portion of the duodenum, to the colon, or to both. Harris (1), Bryant (2) (3).

While the above changes are taking place the colon is rotating about the origin of the superior mesenteric vessels as an axis, the cecum and ascending colon crossing the second portion of the duodenum and descending along the right lateral abdominal wall to the positions occupied in an adult. During this migration, the ascending colon is suspended by a complete mesentery, but when the above mentioned structures reach their destination, the ascending colon adheres to the posterior parietal peritoneum, and, like the duodenum, becomes, in effect, retroperitoneal. This cycle is frequently not completed, however, and numerous variations are seen. The entire colon may remain to the left of the midline or it may be found in its normal position but a part or all of the mesentery of the ascending portion may persist. In these cases the portions

¹Read before the Radiological Society of North America, at Milwaukee, Nov. 29-Dec. 4, 1926.

suspended by the mesentery fail to adhere to the posterior peritoneum and the result is an abnormally mobile ascending colon. Portions of the mesentery may remain as bands even when the ascending colon is fixed to the posterior wall.

Bryant made a careful study of all abdominal adhesions or bands in 297 postmortem examinations, including a relatively large fetal group. In the pre-natal group he found that some type of adhesion was present in 100 per cent of the males and in over 90 per cent of the females. The one most frequently found extended from the cystic duct or the gall bladder to the duodenum and down to the transverse colon. This one was present in 25 per cent of all cases in this group. The second most frequently found was between the cystic duct and the duodenum. In the cases between birth and forty years of age, these same adhesions were the ones most frequently found and their incidence was essentially the same as in the fetal group. In his opinion this offered indisputable evidence of the congenital origin of these bands. Harvey examined a large pre-natal group and his findings were essentially the same as those of Bryant.

Most authorities accept the congenital origin of these bands or adhesions, but there are still a few who consider them to be the result of an inflammatory process. Lane termed them "crystallizations of the lines of force" and considered them to be an attempt on the part of Nature to fix a deformed digestive tube in a better functional position. These latter views are scarcely tenable in the light of the work done by Bryant and Harvey.

OBSTRUCTION NEAR THE JUNCTION OF THE FIRST AND SECOND PORTIONS

Bands about the duodenum have been known for many years to exist, but Harris was the first to point them out as a possible

cause of chronic gastro-intestinal symptoms. He showed that they may cause obstruction at or near the junction of the first and second portions of the duodenum by pressure or by kinking. He found that they may cause symptoms closely simulating those of duodenal ulcer or of gall-bladder disease and that jaundice may be present in some cases although no evidence of disease of the gall bladder or the bile passages is to be found. Furthermore, he proved that patients can be freed from symptoms after the bands have been cut and the duodenum permitted to assume a normal contour.

A number of papers have followed the one by Harris, among which are excellent ones by Kellogg (4), Homans (5), Niles (6) and Taylor (7). In speaking of the methods used in diagnosis, Niles says: "A careful fluoroscopic study is the method of choice and it almost always establishes the diagnosis," and he says further, in speaking of obstruction between the first and second portions: "It continues to be overlooked, I think chiefly because roentgenologists seldom make a sufficiently careful study, especially beyond the first portion, where they look only for ulcer."

Taylor reported 50 cases operated on for this condition, with careful follow-up notes in each. He classified these cases under two types. In the first, pain is the predominant symptom and in this group the stomach is found to be quite high, hypertonic, and peristalsis to be very active. In the second, the symptoms are usually vague, consisting of a dull, dragging sensation in the right upper quadrant, together with eructation of gas, lassitude, and, at times, nausea. In this group the stomach is dilated and atonic and the antrum generally lies to the right of the spine. The duodenal bulb is usually long and moderately dilated and the angle between the first and second portions high and apparently fixed at this point. Taylor believes that the type with pain, and with

hyperactive peristalsis and hypertonicity of the stomach, later shows dilatation and ptosis of this organ. He says: "It is my firm conviction that by this mechanism and sequence of events a large proportion of fish-hook and ptosed stomachs are caused, especially since operative relief from obstruction is followed by rapid improvement in the position and size of the stomach."

Kellogg (4) pointed out that obstruction may result at this same point from a veil of adhesions between the first and second portions, causing increased angulation and sometimes obstruction from pressure. McConnell and Hardman (8) have shown that in a duodenum where the junction of the first and second portions is high and fixed, obstruction may result from kinking, due to the pull of a prolapsed ascending colon on the second portion of the duodenum and on the stomach. The prolapse in these cases results from the presence of a primitive mesentery on the ascending portion, and they have shown that fixation of this segment will relieve the obstruction and free the patient from symptoms.

SYMPTOMS AND TREATMENT

The symptoms of obstruction of this part of the duodenum are varied. As Taylor has pointed out, there are two types. In the one, pain is the predominant symptom. It may come on after meals and be relieved by food or alkalies or it may be aggravated by these. In some of these the pain may simulate gall-bladder disease, at times closely resembling biliary colic. In the second type, pain is much less marked and it is usually more of a dull ache or dragging sensation. The patient is usually under weight, and headache, obstinate constipation, belching of gas, and nausea are frequent symptoms.

Treatment may be either medical or surgical. A majority of cases will be benefited

by the former, consisting of an abdominal support, diet, exercise, and rest. Surgical treatment aims to relieve the obstruction by cutting the bands and freeing the duodenum, thus permitting it to assume its normal contour. Some of these cases are associated with abnormal mobility of the ascending colon, and, unless it is fixed, the obstruction may recur.

CHRONIC OBSTRUCTION BEYOND THE AMPULLA OF VATER

The first point at which chronic obstruction may take place is at the junction of the second and third portions. McConnell and Hardman (8) demonstrated this at operation and reported four cases of this type. In one of their cases there was unusual mobility of the first and second segments of the duodenum and a complete mesentery was present on the ascending colon. A slight pull on the hepatic flexure caused the first portion of the duodenum to descend below the level of the third and caused sharp angulation and obstruction between the second and third parts. Fixation of the ascending colon in this case resulted in a clinical cure.

The next place where obstruction is likely to be noted is at the point where the superior mesenteric vessels cross the transverse portion of the duodenum. Obstruction here is commonly known as gastro-mesenteric ileus. That acute obstruction not infrequently results from pressure of the mesenteric vessels at this point, has long been recognized. The entire subject of acute gastro-mesenteric ileus has been most carefully reviewed by Laffer (9). An excellent paper on this subject was presented by Connor (10). However, only recently, relatively speaking, has the possibility of chronic obstruction at this point been considered. In 1899, Albrecht (11) reported a case of obstruction of the duodenum due to pres-

sure by the superior mesenteric vessels and demonstrated that obstruction could be caused at this point by a pull on the mesentery in the direction of the axis of the pelvis. In 1900, Robinson (12) presented the clinical symptoms and autopsy findings in a case of this type. In Connor's paper of 1906 he said that nothing was known of the clinical manifestations of chronic obstruction by the root of the mesentery, but that it was quite possible that the instances of dilatation of the duodenum, to which Mayo, Finney, and Ochsner had recently called attention, might be due to this cause.

In 1907, Bloodgood (13) demonstrated the association between abnormal mobility of the ascending colon and obstruction of the duodenum behind the mesenteric vessels, and a resection of the cecum and ascending colon in the case reported resulted in a clinical cure. In speaking of chronic gastro-mesenteric ileus he said at this time: "Further experience may demonstrate that this is the common pathological condition of many cases of gastric neuroses, which have not been relieved by posterior gastro-enterostomy and which may be relieved by duodeno-jejunostomy."

Stavely (14) was the first to perform a duodeno-jejunostomy for the relief of this condition. He credits Barker with first suggesting the operation. In his paper, in 1910, reporting cases operated on, he says: "A critical analysis of the many cases of stomach disorders, which are now considered to result from hyperchlorhydria and motor insufficiency, and those whose origin is still in doubt, may show that a fair proportion is due to incomplete obstruction by the root of the mesentery."

Codman (15) presented an excellent paper on this subject in 1908. In it he called attention to wax casts of the duodenum made by Dwight. Most of these showed some flattening at the point where the root of the mesentery crossed the third portion.

In some, the flattening and narrowing was very marked and the duodenum was considerably dilated proximal to this point. He pointed out that obstruction permitted the duodenal secretions to come in contact with the mucosa of the bulb and at times with that of the stomach, and since this mucosa is not normally bathed in these secretions it would be irritated by them and ulceration might result, just as would result were it to be permitted to come in contact with the skin. He considered this to be a possible cause of peptic ulcer.

A number of papers have followed these, but one of the best was presented by Kellogg (4) in 1921. He reviewed the literature carefully, described all the types of obstruction which were known at that time, and presented drawings illustrating the various types seen at operation. He showed that obstruction of the distal part of the second portion of the duodenum can result from prolapse of the hepatic flexure of the colon and pointed out that an abnormally mobile cecum and ascending colon may cause obstruction by tension on the superior mesenteric vessels.

In a recent paper on Chronic Duodenal Ileus, Higgins (16) reports 56 cases seen in the Crile Clinic. In most of the surgical cases, a duodeno-jejunostomy was done, with excellent results.

McConnell and Hardman (8) have described chronic gastro-mesenteric ileus associated with a primitive mesentery on the ascending colon, and have shown that the symptoms may be relieved and that the dilatation proximal to the point of obstruction may disappear with fixation of the ascending colon, when nothing else is done. However, in long-standing cases, they advise that a duodeno-jejunostomy be done, together with fixation of the colon.

Obstruction of the third part of the duodenum beneath the root of the mesentery is generally considered to be due

to pressure by the superior mesenteric artery. Tension on the artery causes this pressure and it may result where the mesentery is long enough to permit the loops of the ileum to slide into the pelvis, but not long enough to permit them to rest on the pelvic floor. Tension may be transmitted through the ileo-colic branch of the superior mesenteric artery. This may be the cause of obstruction, in prolapse of the cecum and ascending colon seen when a primitive mesentery is present on the latter structure. Lordosis and chronic ileal stasis, seen with a "Lane kink" or bands about the cecum, are considered to be predisposing causes.

Obstruction at the junction of the duodenum with the jejunum has been mentioned by several writers, but Lane (17) has given most attention to this subject. He described cases where the obstruction was due to sharp angulation caused by the jejunum turning sharply downward, and at times to the right, instead of passing gradually to the left and downward as is usually the case. He believed that the jejunum assumed this position in periods of fatigue or with chronic stasis in the lower ileum. Both he and Taylor described cases of obstruction due to anomalous bands or membranes about the junction of these two structures. Jordan (18) has done much of the roentgenological work in Lane's cases and has given a graphic description of the fluoroscopic findings in a case of obstruction at the duodeno-jejunal junction. This is the earliest description of these findings given by a roentgenologist and it seems worth while to quote a part of a letter to Lane describing them: "On the couch the dilated stomach was well shown, a considerable portion of it being to the right of the midline . . . the bismuth began entering the duodenum at once but on reaching the third part of the duodenum it advanced no farther, and repeated powerful contractions of the duodenum took place in the endeavor to for-

ward the contents into the jejunum." In another report he speaks of the "duodenum appearing to be writhing in a useless attempt to expel its contents."

SYMPTOMS AND TREATMENT

The symptoms and treatment of the types of obstruction beyond the ampulla of Vater are essentially the same and they will be considered as a group. The symptoms are variable, frequently coming on in attacks with periods when the patient is essentially symptom-free. Pain may be acute or it may consist only of a dragging sensation or dull ache in the epigastric region. With this, there is usually belching of gas, nausea, at times vomiting and headache; the vomitus usually contains bile. Mental depression may be an outstanding symptom. It seems possible that the so-called "bilious attacks" and "sick headaches" may be manifestations of obstructions at these points. Many of the symptoms suggest that they may be toxic in origin and further study may show a relationship between the toxemia observed by Whipple (19) and his co-workers in their work on closed duodenal loops and the manifestations of toxemia seen in these conditions.

The treatment in the majority of cases in this group is medical, consisting of general hygienic measures, diet, rest and usually of a suitable abdominal support. In a few, surgery is advisable and when the obstruction is in the transverse portion or at the junction of the duodenum and the jejunum, a duodeno-jejunostomy is the procedure of choice. Gastro-enterostomy has been disappointing in its results and plastic operations at the duodeno-jejunal angle have seldom been satisfactory. McConnell and Hardman recommend fixation of the ascending colon in the cases where it is abnormally mobile and where this mobility plays a part in the obstruction of the duodenum. They

believe that this procedure in itself will suffice in the majority of cases, but that in longstanding ones, it may be necessary to do a duodeno-jejunostomy as well.

ABNORMAL MOBILITY OF THE CECUM AND ASCENDING COLON AND THE RELATION OF THIS TO OBSTRUCTION AT THE DUODENUM

Waugh (20) presented a paper in 1921 on abnormal mobility of the ascending colon and its pathological significance. While his work in itself was not directly applied to chronic obstruction of the duodenum, it seems wise to call attention to it because of its bearing on the work done by McConnell and Hardman (8). According to him, Pirie, a co-worker, in several hundred post-mortem examinations on unselected cases at the Hospital for Sick Children, found a primitive mesentery or a portion of it on the ascending colon in 20 per cent of all his examinations. Waugh pointed out that a mesentery permits this segment to prolapse and to pull on the narrow mesenteric attachment. This pull is transmitted directly to the right kidney, the duodenum, the stomach by radiation and, when bands are present between the gall bladder and the colon, to the gall bladder itself. He reported 180 cases which had suffered from various chronic gastro-intestinal symptoms, in all of which abnormal mobility of the ascending colon was found and in a large percentage of which fixation of the mobile portion resulted in clinical cures.

Waugh's work has shown that abnormal mobility of the ascending colon is more common than has usually been considered, and the work of McConnell and Hardman (8) indicates that its mobility may be a significant factor in chronic obstruction of the duodenum at any of the above mentioned points. This is an important thing, for, if substantiated, it should influence future operative technic.

Quain (21) has also mentioned cases of duodenal obstruction associated with a mobile ascending colon and has reported a number of cases operated upon, revealing various types of duodenal obstruction. He says Duval has demonstrated anatomically and surgically that obstruction may result from pressure of the middle colic artery on the transverse portion of the duodenum.

ROENTGEN-RAY FINDINGS IN CHRONIC OB- STRUCTION OF THE DUODENUM

With obstruction between the first and second portions, the junction between these parts is seen to be very high and fixed and the angle very acute. The duodenal bulb is long and usually somewhat dilated, and frequently there is delay in the expulsion of the opaque material from it. At times the outline of the first portion is distorted by pressure or tension resulting from the presence of the above mentioned bands. This distortion rarely simulates the findings with ulcer. In these cases the stomach is frequently somewhat dilated and the antrum usually to the right of the midline. In a few cases the first part of the duodenum describes an S-shaped curve. Harris showed drawings of such a case made at operation, the unusual contour being due to distortion by bands.

Obstruction at the junction of the second and third portions, in our experience, is uncommon, but the findings other than the point at which the delay is noted are the same as those with obstruction beneath the mesenteric vessels. In both of these the stomach is usually ptosed, moderately dilated, and peristalsis is usually irregular. It is not uncommon to find a moderate sized six-hour gastric residue. The duodenal bulb not infrequently is long and may be dilated. The opaque material generally passes readily through the first part of the duodenum, through the descending limb,

and to a point in the transverse portion where the progress is seen to stop. Very violent peristaltic waves are then frequently observed, giving the impression that they are attempting to force the material past some sort of an obstruction. At intervals deep waves are seen to sweep the barium back into the duodenal bulb, after which the cycle is repeated. The duodenum is moderately dilated proximal to the point where delay takes place. After varying periods of delay, large masses of barium are seen to pass the point of apparent obstruction and to go rapidly through the remainder of the duodenum into the jejunum.

Jordan has pointed out that this type of obstruction may be transient, especially when in the third portion. For this reason, roentgen-ray examination during a remission may show no evidence of delay. Pylorospasm may be quite marked and it may interfere with proper visualization of the duodenum.

Obstruction of the fourth portion differs in no way from the ones previously described except in its location. It is usually quite easy to demonstrate the difference, since the duodeno-jejunal junction is usually considerably higher and farther to the left than is the point where the third portion is crossed by the mesenteric vessels.

• At the fluoroscopic examination, the hindrance to the passage of material through the duodenum is best shown with the patient upright, viewed in a semi-lateral position, with his right side nearest to the screen. This displaces the shadow of the stomach away from the dependent portion of the duodenum and gives a satisfactory view of the points at which obstruction is likely to occur. Obstruction can usually be demonstrated with the patient in the supine position as well, and at times satisfactory films can be made in both this and the upright position. We have frequently

noticed in obstruction of the third portion that the evidence of delay disappears when the patient is placed in the prone position, especially if the left side is rotated toward the screen. Apparently the tension on the artery is relieved in this position.

Abnormal mobility of the colon seems to bear a definite relationship to the changes in the duodenum in some of these cases. This mobility can be demonstrated by the changes in the level of the hepatic flexure in the upright and supine positions. However, where a band between the hepatic flexure and the cystic duct or gall bladder is present, little evidence of abnormal mobility may be shown except when pressure is exerted on the lateral abdominal wall, in which case the ascending segment can frequently be displaced to the midline or beyond it.

COMMENT

No attempt has been made in this paper to review all the literature on this subject nor to cite cases proving the existence of obstruction. Both have been done by a number of writers and evidence of the latter is such that it can scarcely be questioned. We have attempted to give a brief review of the work of a few men dealing with each type of obstruction and to present the typical roentgenologic findings in these. If the manifestations of chronic duodenal obstruction of the types mentioned are kept in mind, it seems probable that a careful roentgenologic examination of the entire gastrointestinal tract will reveal a definite basis for the symptoms presented in a fair proportion of patients suffering from chronic gastro-intestinal disorders. A knowledge of their basis will result in rational and intelligent treatment, whether medical or surgical, and it is hoped will bring relief to some, who, otherwise, are destined to chronic suffering and invalidism.

SUMMARY

1. Chronic partial obstructions of the duodenum as a result of kinking, of abnormal bands about the junction of the first and second portions or about the duodeno-jejunal junction, or as a result of pressure by the root of the mesentery are definite entities, with characteristic roentgen-ray findings in most cases.

2. A relatively large group of patients suffering from chronic gastro-intestinal symptoms show roentgen-ray evidence of partial obstruction of the duodenum, and both medical and surgical measures for relief of this obstruction have resulted in clinical improvement or cure in a large percentage of cases.

3. Abnormal mobility of the ascending colon is not infrequently seen in cases of this type, and a careful examination of this portion of the colon in both the upright and supine positions may show this association to be more common and more significant than is recognized at the present time.

BIBLIOGRAPHY

- (1) HARRIS: Constriction of the duodenum due to abnormal folds of the anterior mesogastrium. *Jour. Am. Med. Assn.*, April, 1914, LXII, 1211.
- (2) BRYANT: Visceral adhesions and bands: normal incidence. *Am. Jour. Med. Sci.*, 1923, CLXV, 111.
- (3) BRYANT: Visceral adhesions and bands: normal incidence. *Am. Jour. Med. Sci.*, 1922, CLXIII, 75.
- (4) KELLOGG and KELLOGG: Chronic duodenal obstruction, with duodenojejunosomy as a method of treatment. *Ann. Surg.*, 1921, LXXIII, 578.
- (5) HOMANS: A study of the symptoms and treatment of congenital transduodenal bands. *Boston Med. and Surg. Jour.*, November, 1916, CLXXV, 665.
- (6) NILES: Congenital fixation of the duodenum by hepatoduodenal membranes. *Med. Clin. N. A.*, 1924, p. 19.
- (7) TAYLOR: Anomalous abdominal membranes. *Ann. Surg.*, May, 1922.
- (8) McCONNELL and HARDMAN: Abnormalities of fixation of the ascending colon. The relation of symptoms to anatomical findings. *Brit. Jour. Surg.*, 1923, X, 532.
- (9) LAFFER: Acute dilatation of the stomach and arterio-mesenteric ileus. *Ann. Surg.*, 1908, XLVII, 390-416, 532-557.
- (10) CONNOR: Acute dilatation of the stomach. *Am. Jour. Med. Sci.*, 1907, CXXXIII, 345.
- (11) ALBRECHT: *Archiv. für Pathol. Anat.*, bd. 156, 1899, S. 285.
- (12) ROBINSON: Dilatation of the stomach from pressure of the superior mesenteric artery, vein and nerve on the transverse segment of the duodenum. *Cincinnati Lancet-Clinic*, 1900, XLV, 577.
- (13) BLOODGOOD: Acute dilatation of the stomach. Gastro-mesenteric ileus. *Ann. Surg.*, 1907, XLVI, 736.
- (14) STAVELY: Chronic gastro-mesenteric ileus. *Surg., Gynec. and Obst.*, 1910, XI.
- (15) CODMAN: Chronic obstruction of the duodenum by the root of the mesentery. *Bos. Med. and Surg. Jour.*, 1908, CLVIII, 503.
- (16) HIGGINS: Chronic duodenal ileus. *Arch. Surg.*, July, 1926, XIII, 1-42.
- (17) LANE: The kinks which develop in our drainage system in chronic intestinal stasis. *Brit. Med. Jour.*, 1911, I, 913.
- (18) JORDAN: Duodenal obstruction as shown by radiography. *Brit. Med. Jour.*, 1911, I, 1172.
- (19) WHIPPLE, STONE and BURNHEIM: *Jour. Exper. Med.*, 1913, XVII, 307.
- (20) WAUGH: The morbid consequences of a mobile ascending colon, with a record of 180 operations. *Brit. Jour. Surg.*, 1920, VII, 343.
- (21) QUAIN: Pathogenic ptosis of the right colon. *Arch. Surg.*, 1923, VI, 638.

CHRONIC DUODENAL STASIS¹

By EDWARD L. KELLOGG, M.D., and WILLIAM A. KELLOGG, M.D., NEW YORK

From the Department of Gastro-enterology, New York Polyclinic Medical School and Hospital

CHRONIC duodenal stasis or obstruction, as a pathological entity, is still questioned in spite of numerous papers on the subject. The first case was reported by Frederic Boerner in 1752 and in 1820 Yeats described the symptoms.

In America, it was first discussed by Anderson in 1848; later, papers of importance were published, chiefly by German and American investigators. Among contemporary writers are: Lane, Wilkie, Duval, Weiss, McKenty, Codman, Bloodgood, Crouse, Case, Freeman, Coffey, Taylor, Quimby, Cole, Verbrycke, Quain, Higgins, and Halpert. The writers published papers in 1918 and 1921.

ETIOLOGY

The various etiologic factors possess a common attribute in their interference with duodenal motility, leading to the production of mechanical and toxic symptoms.

Extrinsic causes.—Gastroptosis; peritoneal bands; cholecystitis; ptosis of the right kidney; anomalies of the pancreas, including hypertrophy, tumors, bands and annular pancreas; pressure from aneurysm, tumors, and inflammatory conditions; arterial compression acting in conjunction with ptosis of the colon or small intestines and compression of the prolapsed jejunum at the pelvic brim.

Intrinsic causes.—Abnormalities of shape and position; changes in the mucous membrane, including chronic duodenitis; hypertrophy of the valvulae conniventes; congenital narrowing; tumors; ulcer; foreign bodies; localized hypertrophy of the muscle layer (Ochsner).

Any portion of the duodenum may be affected.

Only the more important causes will be discussed.

GASTROPTOSIS

Gastroptosis increases the acuteness of the superior duodenal angle, the stomach being suspended from this fixed point. Ultimately, the stomach dilates with stagnation of its contents. If the superior duodenal angle prolapses, the point of obstruction is transferred to the inferior angle, mesenteric root or duodeno-jejunal angle. Chilaiditi describes these secondary changes in the duodenum as varieties of duodenal ptosis.

Finney suggests that a ptosed, dilated stomach may increase obstruction by compressing the mesenteric root.

DUODENAL BANDS

Duodenal bands and membranes are developmental or inflammatory. As a result of non-absorption of embryonal folds, the lesser omentum, which supports the stomach and the duodenum, may extend to the right, partially or completely covering the gall bladder. Below, it may extend over the second duodenal segment to the transverse colon or beyond it to the great omentum forming the hepato-duodeno-colic ligament, also termed the cysto-colic fold and the cysto-epiploic ligament. This may be narrow and band-like or spread roof-like over the gall bladder, covering the fundus completely, and holding it in contact with the pylorus and first part of the duodenum (Brewer reports 3 per cent in 100 cases). Occasionally it completely closes the foramen of Winslow, according to Ancel and Sencert. The combined statistics of a num-

¹Presented before the Radiological Society of North America, at the Twelfth Annual Meeting, at Milwaukee, Nov. 29-Dec. 4, 1926.

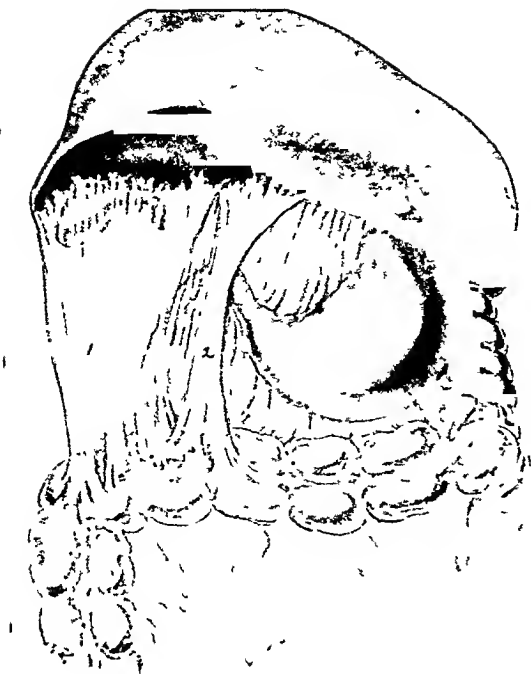


Fig 1 Hepato-duodeno-colic membrane (the cysto-colic or cysto-epiploic fold) 1, The main hepato-duodeno-colic membrane, completely covering the gall bladder; 2, the accessory hepato-duodeno-colic band

ber of observers show that it occurs in some form in about 22 per cent of cases

Authors	Number of Cases Examined	Present
Jonnesco	100.....	25
Addison	40.....	30
Mollison and Cameron 50.....		20
Buy		25
Bricon	80.....	15
Reid	50.....	28
Leveuf	50.....	28
Suslow	145.....	18
Testut (Kehr)	100.....	16
Mayo	150.....	12

In the study by Mollison and Cameron (50 cases), 6 were fetuses and 17 under five years of age. In Reid's observation of 50 fetuses, the membrane was present in 28 per cent, and Leveuf gives the same statistics for 50 infants examined shortly after birth. Hushke describes a duodeno-colic ligament between the first duodenal segment and the right extremity of the transverse colon. Oc-

asionally this is united to the hepato-duodenal ligament by a band crossing the duodenum, forming an accessory hepato-duodeno-colic ligament.

Hushke also describes a duodeno-renal ligament uniting the superior duodenal angle to the upper extremity of the right kidney. It is triangular in shape and has a free margin directed to the right and two adherent margins, one extending from the pole of the kidney to the vena cava, and the other to the duodenal angle. It is often continuous with the hepato-renal ligament behind and the cysto-colic ligament in front. United, these three ligaments form a sort of funnel as a vestibule to the entrance to the lesser peritoneal cavity.

Adventitious bands in the form of thin veils or firm dense membranes may be caused by cholecystitis, duodenitis, or colitis (periduodenitis of Duval). They may unite the first and second duodenal segments, hold the second portion in contact with the liver or gall bladder, or bridge over it by bands extending from the liver or gall bladder to the stomach or colon. Adhesions of the gall bladder to the duodenum, stomach, or hepatic flexure may directly compress the duodenum. Retroperitoneal adhesions occur at the inferior angle or cross the third portion or the duodeno-jejunal angle.

The etiology of membranes associated with the normal peritoneal distribution, without evidence of inflammation, has been the subject of considerable discussion. Although membranes, found in the adult, are duplicated in the fetus and newborn infant, several writers consider them the result of low grade peritonitis secondary to intestinal infection; others believe them to be unabsorbed remnants of normal fetal folds which have been subjected to inflammatory changes. The evidence favors the latter theory.

These bands may kink the duodenum or compress it by the pull of organs to which



Fig 2 Acquired bands, secondary to appendicitis, obstructing the first portion of the duodenum

they are attached or by direct pressure. As a result the superior angle may be highly placed and more acute than normal or dragged upon by the duodeno-renal ligament, when the right kidney is prolapsed, or by the duodeno-colic (cysto-colic or cysto-epiploic) and accessory hepato-duodeno-colic band, in prolapse of the colon. The main hepato-duodeno-colic band compresses the second portion by traction, in prolapse of the hepatic flexure, or by direct pressure in hyper-fixation of the hepatic flexure. The duodeno-jejunal angle may be drawn up by contraction of the ligament of Treitz and the duodeno-mesocolic band may swing the jejunum to the left or right or twist it upon the duodenum.

It thus becomes a factor of importance in determining the position of the jejunum in gastro-enterostomy, the turn to the right favoring Moynihan's no-loop operation, that to the left, the procedure of Mayo.

Secondary changes occur in the duodenum and stomach. The caliber is narrowed at the point of pressure and proximal to it



Fig 3 Acquired band, extending from liver to transverse colon, obstructing the second portion of the duodenum. Severe headaches and attacks of bilious vomiting were relieved by division of the band

there is, first, hypertrophy and hyperperistalsis, later atony, dilatation and stasis. The pyloric antrum is pushed to the right, causing the duodenum to bend sharply backward, upward, and inward, thus increasing functional disturbance. The pylorus, at first hypertrophied and spastic, ultimately becomes incompetent.

The cystic duct may be constricted or angulated, interfering with gall-bladder drainage and resulting in acute attacks resembling biliary colic.

ARTERIAL COMPRESSION

Duodenal stasis following arterial compression has been discussed by several authors. In 1897 Thomas Dwight made a series of casts of the duodenum which have been studied by the writers. In infants these show little evidence of angulation or compression, but in adults there are marked variations in size and shape and certain anatomical markings uniformly present.

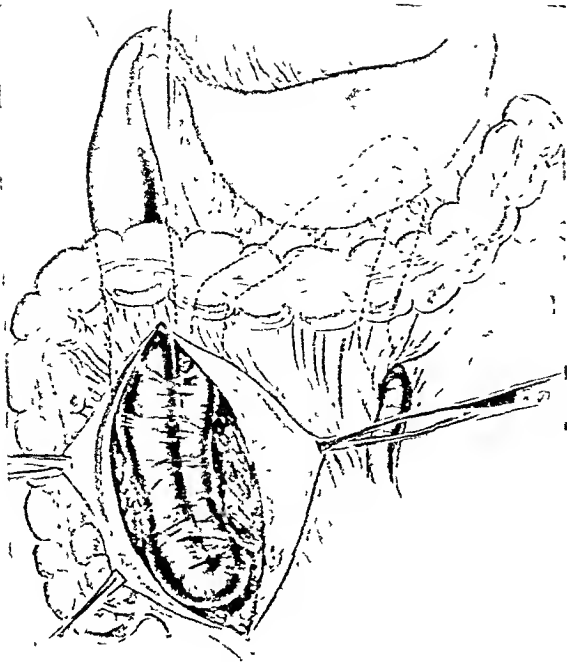


Fig. 4. Retroperitoneal adhesions at the inferior angle binding together the second and third portions, resulting from duodenitis. In this case the duodenum was elongated so that it extended down to the pelvic brim.

Those of chief interest are a broad groove on the posterior surface at the point of contact with the spine and aorta, and on the anterior surface a narrow groove caused by the pressure of the superior mesenteric artery. Proximal to this, in the second and third portions there are also occasional well-defined notches which are possibly due to pressure by branches of the superior mesenteric artery, since they correspond with the usual location of these branches. It is evident that a sufficiently increased pressure might interfere with function, and that this occurs has been proven by clinical and experimental evidence.

The arterial supply of that portion of the colon intimately related to the duodenum is usually as follows: The superior mesenteric artery arises from the aorta above the duodenum, which it crosses and gives off the mid-colic, right colic, ileo-colic, and terminal branches to the small intestines. The mid-colic may arise from the superior mesenteric

where it emerges from the pancreas and reach the transverse colon without crossing the duodenum, or it may originate at a lower point and cross the third portion. The right colic originates below the media, in the first instance crossing the third portion, in the second instance being below it. The arterial arch, formed by the anastomosis of these trunks, sends branches to the hepatic flexure, crossing the second duodenal segment. The ileo-colic branch is usually given off below the duodenum and is distributed to the lower ileum and cecum.

The arterial walls possess little elasticity as compared with the tissues that surround them, and when the organs to which the arteries are distributed become prolapsed, the latter become their chief support and may compress the duodenum. For this reason, prolapse of the small intestine compresses the third duodenal segment by a direct pull upon the superior mesenteric artery, providing that the prolapse is not sufficient to permit the intestines to rest upon the pelvic floor, since this support relieves the drag upon the artery. Prolapse of the cecum drags upon the ileo-colic and, through it, upon the superior mesenteric, causing compression at the same point. With the descent of the hepatic flexure the right colic, when it crosses the duodenum, compresses the second or third segments proximal to the mesenteric root. With prolapse of the transverse colon the mid-colic may cause direct pressure if given off above the duodenum, or pull upon the superior mesenteric if given off below. In high fixation of the hepatic flexure, a branch of the arterial arch may be found in the areolar tissue pressing upon the second segment. More than one artery may be involved and a combination of arterial compression and congenital or acquired bands is common.

Kiek has found in some instances an ileo-pelvic band extending to the left side of the mesentery, pulling it down to the brim of

the pelvis, division of which permits relaxation of the mesentery and superior mesenteric vessels.

The secondary changes in the stomach and duodenum are identical with those in compression by membranes.

COMPRESSION AT THE PELVIC BRIM

A variety of obstruction that has not been described may occur with prolapse of the small intestines into the pelvis. Occasionally they are wedged in tightly and the jejunum is pressed so firmly against the pelvic brim that it is partially obstructed. At operation the jejunum is dilated down to the brim of the pelvis, and when disengaged, often with an appreciable effort, a distinct transverse groove will be observed marking the point of pressure and the limit of dilatation. It is known that in thin individuals the small intestines frequently occupy the pelvis and it is probable that much abdominal discomfort may result from the distention of the intestines, limited by the bony framework. This may be a cause of obscure left-sided abdominal pain

ANNULAR PANCREAS

Rarely the second segment will be obstructed by the pancreas. There may be simple hypertrophy of the head, partially surrounding the duodenum, or the circle may be completed by a band of fibrous tissue uniting the two glandular processes, or the pancreatic substance may completely surround the duodenum, the true annular pancreas.

Abnormalities in the shape and position of the duodenum may produce symptoms of duodenal stasis and complicate surgical procedures. Variations from the normal appear to depend chiefly upon anomalies of development such as faulty rotation or fixation of the duodenum, abnormally long duodenum, faulty rotation or non-rotation of the colon. Less frequently they are ac-



Meso-colic Adhesions causing kink at duodeno-jejunal junction.

Fig 5. (After Gray and Anderson)

quired as a result of pathological changes weakening the abdominal wall and causing ptosis of the stomach, right kidney, hepatic flexure of colon, and the duodenum itself. The varieties of duodenal ptosis have been referred to.

NON-ROTATION OF THE DUODENUM

A common anomaly of development is the failure of the duodenum to cross the vertebral column, regularly occurring in non-rotation of the colon, but also existing independently of it. Faucet and Blatchford found it four times in 337 autopsies (1 per cent).

The disposition of the duodenum will vary, apparently depending upon its length, although other factors may be responsible for secondary changes in the loop. In the simplest form the third and fourth portions are absent, the first and second forming a simple curve convex to the right, joining

SYMPTOMATOLOGY

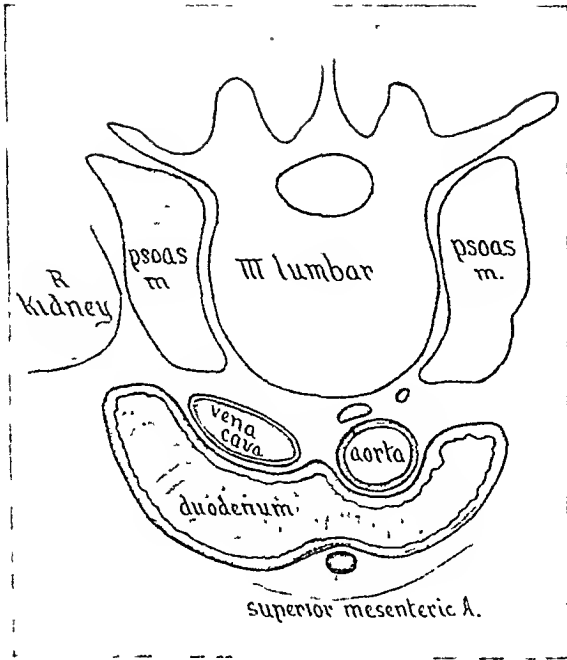


Fig. 6. Transverse section of the human body showing relation of duodenum to spine, aorta, and superior mesenteric artery, and the normal compression of the third portion. (From authors' paper in *Surg, Gynec and Obst.*, Feb., 1918, pp. 174-182.)

the jejunum beneath the hepatic flexure of the colon. In other instances the curve may be sufficiently long to reach the pelvic brim, either external or internal to the cecum and ascending colon, or it may present irregular coils or loops. The changes described may also occur with the duodeno-jejunal angle in its normal position.

The intimate relation between the right kidney, hepatic flexure of colon and duodenum, makes it easy to understand a ptosis of the inferior duodenal angle accompanying prolapse of these organs and compression of the duodenum occurring not only through the drag transmitted to the superior mesenteric artery but also to the drag upon the mesocolic attachment, as emphasized by Halpert. Harman has described cases in which, in addition to abnormal looping, above, the duodeno-jejunal angle turned to the right, the jejunum passing across the vertebral column from left to right, beneath the peritoneum.

Taylor, writing of obstruction caused by membranes, observes that "symptoms result when the obstruction becomes greater than the peristaltic efficiency can easily overcome. This balance may be gradually lost with slowly increasing symptomatology. It may be suddenly lost as a result of a prostrating injury or illness, the obstruction remaining constant, while the viscus, becoming atonic, is no longer competent to overcome it. Sometimes the viscus regains its relative tone and the symptoms improve. Often it fails to overcome the handicap and the symptoms are continuous and progressive."

This statement applies equally to all forms of compression. The symptoms may be chiefly toxic or mechanical or they may be combined and modified by the relation of the obstruction to the ampulla of Vater. The toxic symptoms include headache, neuralgia, mental and physical depression, disturbed heart action, cold extremities, hyperesthesia, parasthenia, skin eruptions, loss of weight, and digestive vomiting. There is considerable variation in the mechanical symptoms. When the first portion only is involved, they suggest pyloric obstruction. Harris finds that remissions are common. He notes a feeling of epigastric distress or pressure, or a sharp pain two or three hours after meals, relieved by food, accompanied by epigastric tenderness and excessive secretion of hydrochloric acid. To these may be added vomiting of food and acid secretions (not of bile) at a time when the stomach is normally empty. Forced eructations are common. Obstruction at the ampulla of Vater may cause papillary stenosis with chronic jaundice, acholic stools, enlarged and sensitive liver, and pain referred to the right costal margin. With obstruction below the ampulla of Vater there may be added vomiting or regurgitation of bile and

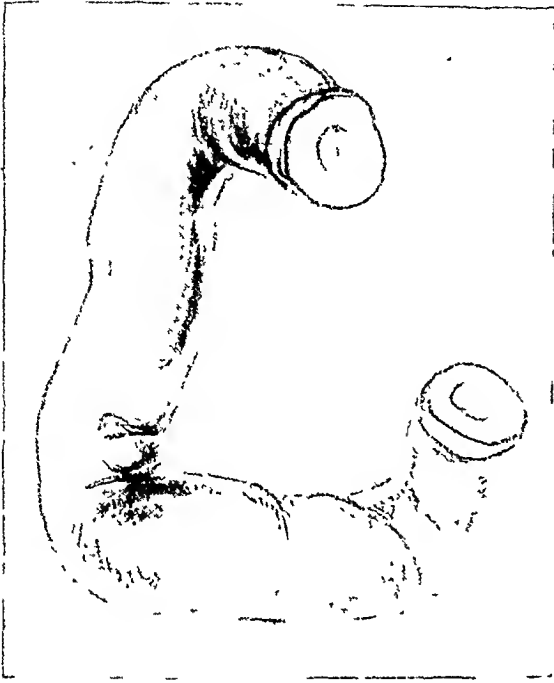


Fig. 7 Cast of normal infant's duodenum (From author's paper in *Surg, Gynec. and Obst*, Feb, 1918, pp 174-182)



Fig 8 Cast of adult duodenum. (From authors' paper in *Surg, Gynec. and Obst*, Feb, 1918, pp. 174-182)

pain or tenderness referred to the point of obstruction.

If the colon is at fault there are periods of comfort when the bowels are functioning normally. When constipated, the drag of the bowel inaugurates a "bilious attack," characterized by headache, nausea, and vomiting of bile. The condition of the pylorus modifies the symptoms: when spastic, pain is prominent; when relaxed, regurgitation or vomiting of bile may occur without pain. Following an attack of pain, something may be "felt to give way" (apparently the resisting pylorus yielding to pressure), the pain subsides, and vomiting or regurgitation of bile follows. Two areas of discomfort are commonly observed: at the left of the median line, slightly above the navel, and above and to the right of the navel extending under the liver and to the shoulders. This may be a painful colic, intense and boring in character, due to peristaltic unrest, or a steady dull ache, due to distention, often lasting until relieved by vomiting. Oc-

casionally pain is limited to the back, between the shoulders. The discomfort may be relieved by deep pressure below the navel. Patients occasionally lie face downward with the fists pressed into the abdomen. Apparently the pressure relieves the obstruction. Attacks of pain may simulate duodenal ulcer or chronic appendicitis. Kinking or narrowing of the cystic duct may occur and lead to distention of the gall bladder, and biliary colic. Headache is frequent, usually temporal or frontal, recurring regularly during the height of digestion or in attacks with nausea, vomiting, and visual disturbances. Duval describes attacks of duodenal migraine which may coincide with attacks of abdominal pain and terminate in diarrhea and bilious vomiting. Vomiting is not regularly present in obstruction above the ampulla unless gastric retention occurs. Vomiting of large quantities of bile may be the chief complaint when the obstruction is below the ampulla. If the pylorus does not

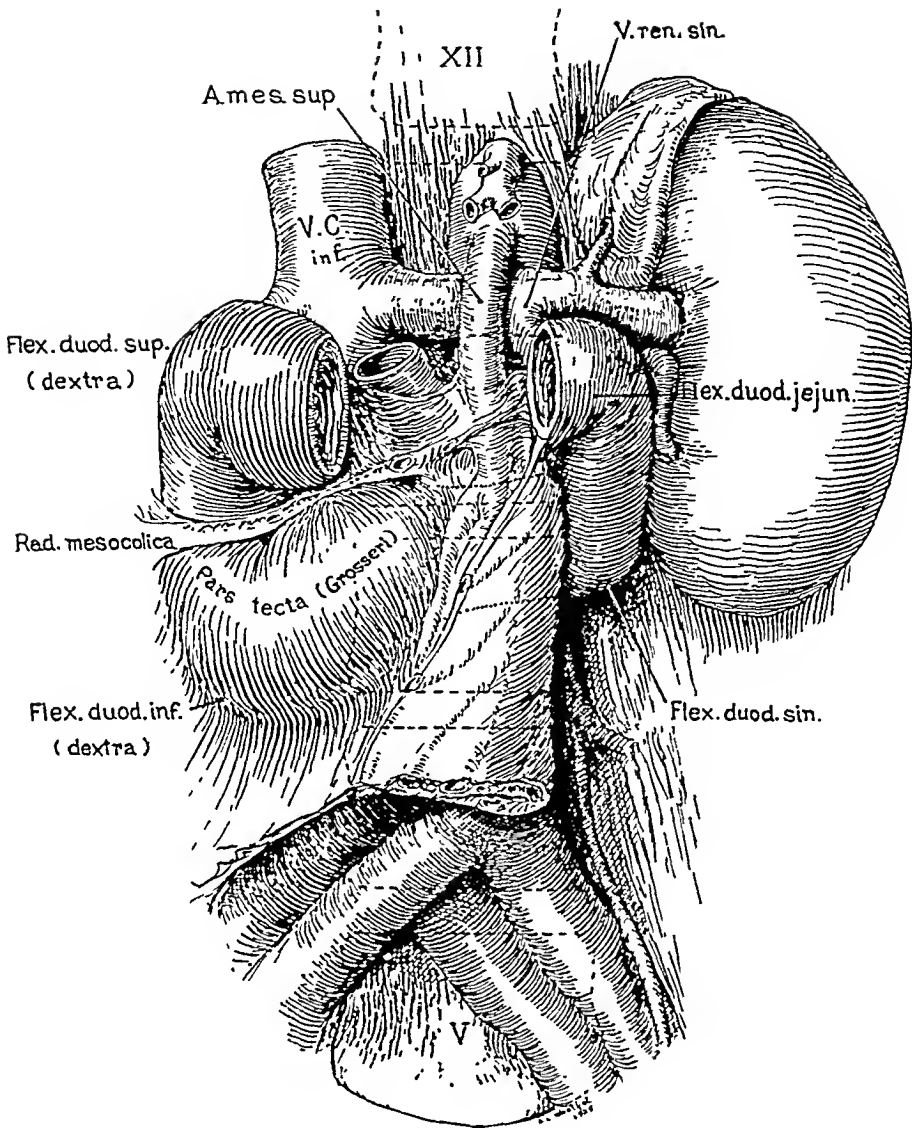


Fig. 9. The topographical relations of the duodenum, the left renal vein, and the superior mesenteric artery. (Borrowed from a paper by Halpert and published with the permission of the author.)

yield, diarrhea may take the place of bilious vomiting.

PHYSICAL SIGNS

The physical signs may be negative or diagnostic. Obstruction above the ampulla resembles pyloric obstruction or gastropotosis. When the lesion is below the inferior angle, a tympanitic area may be found behind the right rectus muscle to the right of or below the pylorus, between the liver and transverse colon. Percussion

should be employed with sufficient pressure to diminish the gastric and colonic tympany, bringing the examining finger closer to the duodenum. Pressure upward and backward beneath the transverse colon permits the duodenum to empty. Gas can be felt or heard escaping into the jejunum, after which the percussion note becomes relatively dull with diminution in the area of tympany (Hayes' procedure). Duodenal succussion, the splashing sound (emphasized by Cash), is also an indication of duodenal stasis.

The combination of these physical signs with characteristic symptomatology enables one to diagnose duodenal dilatation with considerable confidence, but they will be absent if the duodenum is over-acting, hypertrophied, or if empty and collapsed, as may result from laxative medication.

The roentgen-ray study of obstruction of the first and second portions usually makes the diagnosis clear, but in mesenteric compression a negative report is not uncommon since the mechanism may not be constantly operative and peristalsis may be stimulated by a preliminary cathartic. The changes in the duodenum follow one of four types:

1. *The asthenic duodenum* (symptoms latent or toxic). The roentgen examination may show delay or puddling in the duodenum, with sluggish peristalsis and slight or no dilatation.

2. *Duodenal obstruction, with incompetent pylorus*. Bile regurgitates easily into the stomach. Dilatation is usually moderate or absent. Roentgen-ray examination is negative or shows reverse peristalsis.

3. *Obstruction, with hypertrophy* (the writhing duodenum). The duodenum is elongated and its walls are thickened. Under the fluoroscope it is seen to labor over its contents. Cramp-like pains are common.

4. *Dilated duodenum*. The area of duodenal tympany is increased, succussion is present. Pain occurs, either steady and dull or cramp-like. This variety is most readily demonstrated by the roentgenologist.

From a practical operative viewpoint, when the abdomen is opened for upper abdominal symptomatology, the transverse colon should be raised upward and one should observe whether or not the inferior angle and the third portion of the duodenum bulge through the peritoneum below the transverse mesocolon.

It may be well argued that the presence or absence of the protrusion of the duodenum below the mesocolon is not a fixed re-

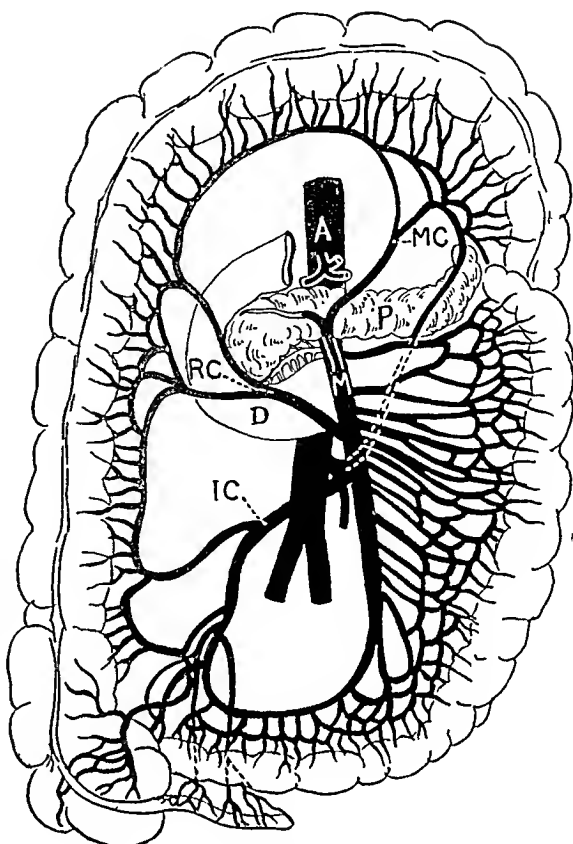


Fig. 10. The arterial supply of the colon in relation to the duodenum. A, aorta; P, pancreas; D, duodenum; M, superior mesenteric artery; I-C, ileo-colic branch of superior mesenteric; R-C, right colic branch; M-C, mid-colic branch.

lationship. However, in the presence of symptoms suggestive of duodenal interference we feel that its presentation several inches below the transverse mesocolon, especially if its caliber is considerably greater than that of the jejunum, is indicative of a pathologic condition.

TREATMENT

The majority of cases are amenable to treatment given for enteroptosis and intestinal stasis. Surgery is indicated when medical treatment fails and some cases are plainly surgical in the beginning, notably those in which the duodenum is greatly dilated or is causing frequent copious regurgitation of bile. The choice of procedure will depend chiefly upon the mechanical con-

dition present; to a lesser degree, upon the symptom complex.

GASTROPEXY

Gastropexy is indicated in obstruction of the first portion with gastropnoxis, when the superior angle is normally placed and free from pathology except for the kinking

well with medical treatment, and when, because of faulty development of the lower thoracic region, the liver fills the upper abdomen almost completely, there is no room for replacement of the stomach by this operation, but it is particularly applicable where there is a "roomy" abdomen and a broad sub-costal arch.

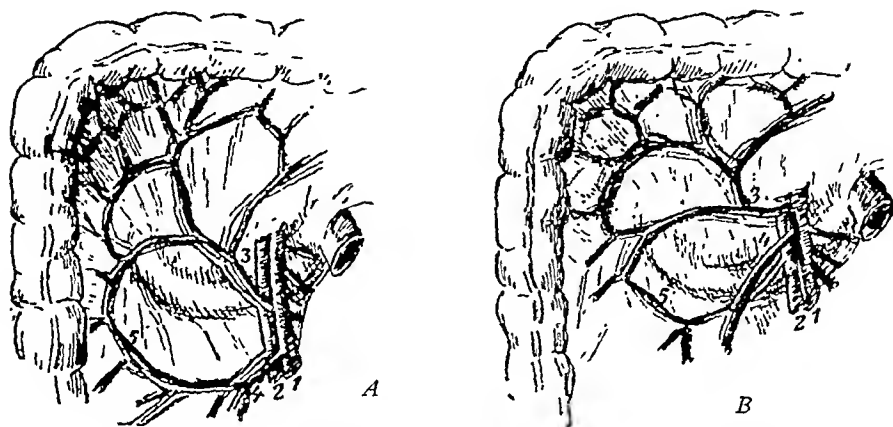


Fig. 11. Variation in the arterial supply of the colon in its relation to the duodenum. (After Schumacher.) 1, Superior mesenteric artery; 2, vein; 3, mid-colic artery (see *A*) crossing of the transverse duodenum from below upwards—(see *B*) above and not crossing the duodenum; 4, right colic artery (see *A*) given off below the transverse duodenum and not crossing it—(see *B*) crossing obliquely to the right; 5, communicating arch between mid-colic and right colic arteries.

caused by the drag of the stomach; also to supplement other procedures when the gastropnoxis is a secondary factor.

Beyea, who recommends this operation, remarks that, "The completeness of relief and the extraordinary restoration to health of these patients, who have suffered for years, the simplicity of the operation, which restores the stomach to a normal position by shortening the natural ligaments, without removal of tissue or formation of abnormal adhesions, and the fact that it is practically free from mortality ($\frac{1}{4}$ per cent) must strongly recommend this operation, at least in every case in which the suffering is great."

One cannot endorse these conclusions without reserve, but in properly selected cases the operation does all that is claimed for it. Cases of moderate gastropnoxis do

GASTRO-ENTEROSTOMY

Gastro-enterostomy is the choice of some surgeons, and apparently has been satisfactory in the cases reported. It appears to the writers, however, that in some instances other procedures would have met the indications without disturbing the physiology of the stomach. It is particularly applicable in multiple lesions not easily corrected, chiefly in extensive dense adhesions involving the first and second portions. It should be supplemented by pyloric exclusion.

PLASTIC OPERATIONS

Division of adhesions, and readjustment of the duodenum, with or without omental grafts, is useful when the membranes interfere with the first or second portions.

If the superior angle is drawn up too high by contraction of the duodeno-hepatic

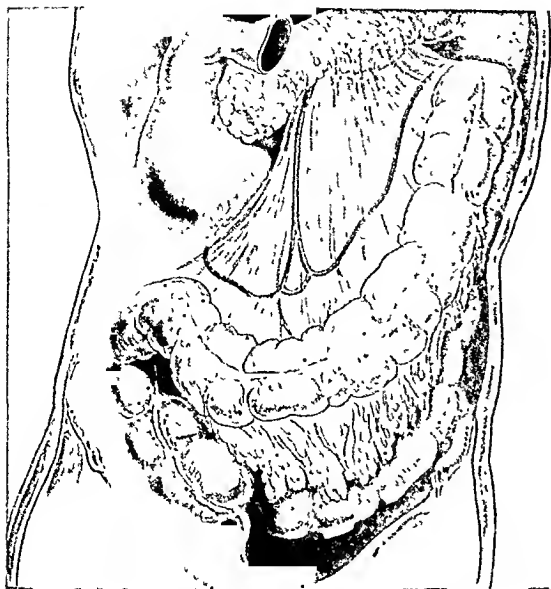


Fig. 12. Compression of the duodenum by the mid-colic artery in prolapse of transverse colon. (After Duval.)

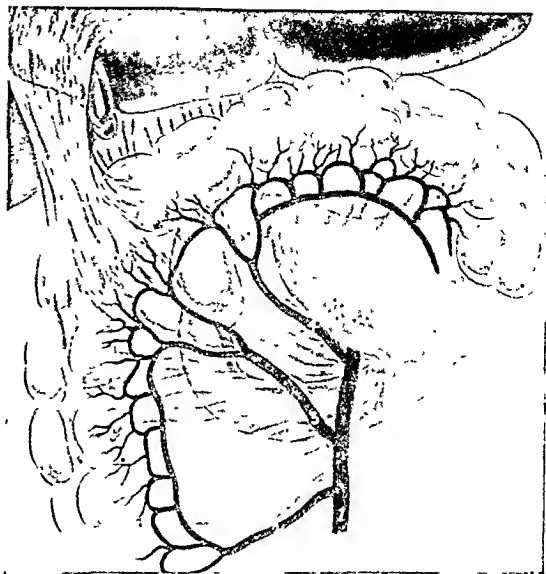


Fig. 13. Obstruction of descending duodenum by a branch of the right colic artery in high fixation of hepatic flexure. 1, Superior mesenteric artery; 2, ileo-colic; 3, right colic; 4, mid-colic.

ligament, or compressed by the accessory hepato-duodeno-colic band, it can be corrected by a simple incision crossing the band transversely, freeing and lowering the superior angle and covering the denuded surface by suturing the peritoneum in a vertical direction. A similar technic may be applicable in compression of the second portion by the main hepato-duodeno-colic band. If the denuded surface cannot be properly covered by suture, an omental graft, free or attached, will meet the indications.

CHOLECYSTECTOMY

Cholecystectomy may appear to be indicated when an extensive surface has been denuded by separating adhesions between the gall bladder and duodenum. Secondary adhesions to the liver usually follow and this operation should be supplemented with an omental graft. The interposition of the graft alone is usually sufficient and cholecystectomy should probably be reserved for cases in which there are symptoms of obstruction of the cystic duct. Cholecyst-gastrostomy or cholecyst-enterostomy are

only indicated in papillary stenosis. Stretching the mesenteric opening to relieve constriction at the duodeno-jejunal angle has benefited some cases, but the probability of recurrence limits its usefulness.

Stretching or dividing the ligament of Treitz is recommended by Freeman. It permits lowering of the duodenal-jejunal angle and corrects obstruction due to contraction of this ligament and may relieve mesenteric compression by displacement of the third portion. Suturing the mesenteric root to the inferior surface of the transverse mesocolon has been recommended, and although it impresses one as being an inadequate procedure, it may prove of value when the jejunum is compressed at the pelvic brim.

OPERATIONS UPON THE COLON

Operation upon the cecum, ascending or transverse colon is indicated if the clinical picture is complicated by colonic stasis and the duodenal compression is found to be due to the pull upon the mesocolic attachment or to the drag upon the superior mesenteric artery transmitted through the ileo-colic.

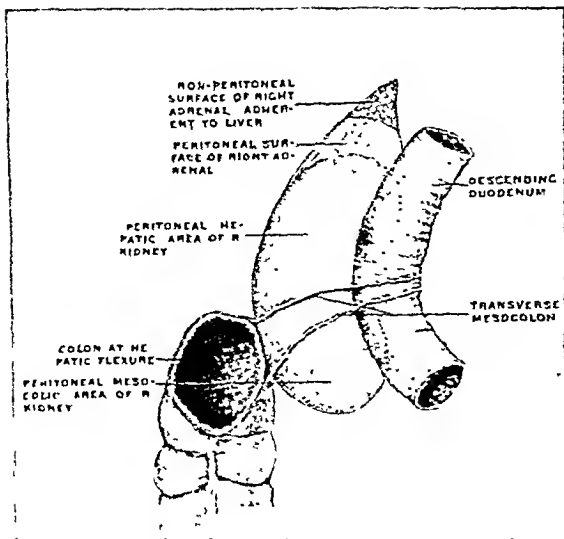


Fig. 14. Peritoneal relations of duodenum, colon, and right kidney. (After Huntington.) Prolapse of the kidney or of the hepatic flexure of the colon may interfere with duodenal motility.

The procedures include division of constricting bands, plication and fixation of the cecum and ascending colon, to hold the cecum above the pelvic brim, and restoration of the hepatic flexure. Resection of the cecum and ascending colon, recommended by Bloodgood, may be required if simpler measures are inadequate.

In hyper-fixation of the hepatic flexure, due to contraction of the hepato-duodenocolic band, possibly with pressure upon the descending duodenum by a branch of the right or mid-colic arteries, the band should be divided and in addition the hepatic flexure lowered. If prolapse of the transverse colon causes duodenal compression through the mid-colic artery, it may be relieved by suturing the omentum to the abdominal wall (Coffey operation) or by taking a reef in the gastro-colonic omentum. Duodeno-gastrostomy and duodeno-duodenostomy may be useful in obstruction at the superior angle when adhesions are too extensive to be treated by plastic procedures. If the parts to be anastomosed are held in contact by adhesions, it is easily done and usually with

gratifying results. Duodeno-jejunostomy, the technic of which has been described in an earlier paper, is the operation of choice in obstruction of the third portion, including a vicious circle after gastro-enterostomy and accompanying gastro-enterostomy when the duodenum is obstructed, unless there is a definite indication for other procedures. It resembles gastro-enterostomy, and, although technically more difficult, the mortality is lower and post-operative complications less apt to occur.

The approach to the duodenum is usually through the mesocolon or posterior peritoneum, depending upon the amount of dilatation and the arterial distribution in the mesocolon. Schumacher's observation that one may safely ligate the anastomatic branch between the right and mid-colic arteries may be useful in this connection. Duval has described a transmeso-colic procedure with supplementary entero-anastomosis.

SUMMARY OF CASES

In 1921 the writers reported 41 cases treated by duodeno-jejunostomy, of which at that time 36 were completely relieved of their symptoms, four markedly improved and one unimproved. Recent attempts to obtain reports have brought only ten replies. Of these, three patients have remained free of all symptoms, four have remained greatly improved in health but occasionally have intestinal discomfort, and three have not been permanently benefited.

The present study is based upon the additional cases treated by duodeno-jejunostomy and those subjected to other procedures.

Several reports are not available so that this series includes only one duodeno-duodenostomy, although the operation has been performed several times either alone or combined with other procedures.

The list includes:

Duodeno-jejunostomy alone, or with treatment of adhesions.....	30
Duodeno-jejunostomy and gastro-enterostomy	5
Duodeno-jejunostomy and duodeno-duodenostomy	1
Plastic operations for duodenal and gall-bladder bands or membranes ...	31
Plastic operations for duodenal bands and some procedure applied to the colon	15
<i>Total</i>	<i>82</i>

Of the 30 cases of duodeno-jejunostomy alone, 18 remain free of symptoms, 9 have been markedly improved with no return of vomiting or epigastric pain but still complain of constipation, distention and occasional headaches, three are no better—of which two had so much abdominal pathology that definite results were hardly to be expected. The total number of duodeno-jejunostomies alone or in combination with other procedures is 77

In the earlier series there were no fatalities. In the present group one case of duodeno-jejunostomy, with division of adhesions, died of embolism; another died following a subsequent resection of the cecum and ascending colon

Among those treated by division of bands were two in which the hepatic flexure was drawn up by a contracted membrane and the descending duodenum was definitely compressed by a branch from the anastomosis between the mid-colic and right colic arteries. This condition probably escaped recognition in earlier cases. In two cases the jejunum was definitely obstructed by compression of the prolapsed intestine at the pelvic brim. In other cases the groove marking the compression of the jejunum has been observed but its significance was not appreciated until these cases of acute



Fig 15 Hepato-duodeno-colic band crossing the superior duodenal angle and causing partial obstruction. Transverse incision to permit lowering of angle

obstruction occurred. In two cases glycosuria was marked and was greatly improved after operation.

Some years ago the literature contained references to duodenal diabetes, so called, but it has not been recently discussed.

In 1907 Pflüger devised a method of separating the nervous connection between the duodenum and pancreas of frogs without disturbing the circulation. Of 16 frogs subjected to operation, 14 showed persistent glycosuria.

Zak has pointed out the possibility of glycosuria following lesions of the duodenum from poisoning with caustic substances, and Lancreaux, without presenting conclusions regarding the duodenum, in a paper on two cases of diabetes with pancreatic lesions, also observed hypertrophy of the duodenal glands and microscopic changes in the mucosa

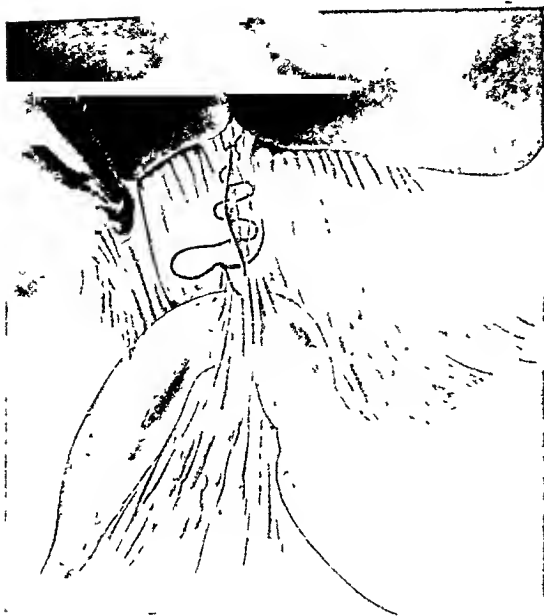


Fig. 16. Hepato-duodeno-colic band Treatment after transverse incision: suture in vertical direction lengthening the band and permitting the lowering of the superior duodenal angle.



Fig. 17. Hepato-duodeno-colic band. Free omental graft applied to cover denuded surface left after division of band and lowering of superior duodenal angle.

Approaching the subject from a clinical point of view the writers have been impressed with the occasional association of glycosuria with duodenal pathology as observed by X-ray investigations.

While the reports are not sufficiently numerous to establish a relationship between the conditions, they justify further study of the problem.

CONCLUSIONS

Duodenal stasis exists as one of the manifestations of enteroptosis and also as a pathological entity due to a number of mechanical conditions.

Symptoms are modified by the relation of the obstruction to the ampulla of Vater.

Cases due to gastropexy may be treated by mechanical support or by gastropexy.

Duodenal bands produce symptoms when contracted by inflammation or dragged upon by the prolapsed bowel. An accessory hepato-duodeno-colic band may cross the superior angle.

Retroperitoneal adhesions at the inferior angle may result from duodenitis.

Abnormalities of shape are due in part to faulty rotation of the duodenum.

Two new varieties of obstruction have been observed, the first due to prolapse of the small intestines into the pelvis and compression of the jejunum at the pelvic brim the second a variety of arterial compression occurring in hyper-fixation of the hepatic flexure and caused by pressure of a branch from the anastomatic arch between the right colic and mid-colic arteries.

Compression of the third portion is largely dependent upon the anatomical arrangement of the superior mesenteric artery and its branches.

Duodeno-jejunostomy is most frequently indicated in obstruction of the third portion.

Next in importance will be some procedure applied to the colon.

Glycosuria and possibly true diabetes is associated with duodenal pathology with sufficient frequency to justify study of the problem.

REFERENCES

- ANDERSON: Stricture of duodenum. New Orleans Med. and Surg. Jour., 1848, V, 480.
- ANCEL, P., and SENCERT, L.: Maphologie du péritoine et des ligaments hépatique accessoires, chez l'homme. Jour. de l'Anat. et de la Physiol., 1903, XXXIX, 353.
- ADDISON, C. J.: Anatomy and Physiology, 1900, XXXV, 200.
- ANCELET: Etudes sur des Malades du Pancreas. Paris, 1866. Quotes Auborg (Annular Pancreas).
- ANDERSON, J. H.: Brit. Jour. Surg., 1922, X, 316 (Annular Pancreas).
- BAUMEL: Duodenitis Ieterus Diabetes: Montpellier Med., 1887, 2d series, p. 386 (Duodenal Diabetes).
- BOERNERUS, F.: De Tabæ Sicca Lethæale A. Mirrabili Duodeni Angustia et Præternaturali, Plane Ventriculi, Situ Disquisito Anatomico-Medico-Practica, Academiæ Cæsariæ Naturæ. Curiosum pensi Ordinarii Loco Oblati. Acta Acad. Nat. Curios., 1752, p. 225.
- BROMAN: Secondary Adhesions in the Peritoneal Cavity. Handbuch der Anatomie des Muenchen, June, 1914, III, 81.
- BREWER, C.: Med. News, 1903, LXXXIII, 821.
- BUY: Bibliog. Anat., 1903, XII, 65.
- BRICON: Progrès méd., 1888, VII, 27.
- BEYEA: Phila. Med. Jour., 1901, I, 257.
- BLOODGOOD, J. C.: Dilatation of the duodenum in relation to the surgery of the stomach and colon. Jour. Am. Med. Assn., July 13, 1912, LIX, 117.
- IDEM: Acute dilatation of stomach; gastro-mesenteric ileus. Ann. Surg., 1907, XLVI, 736.
- BECONET, M. SCHURMANN: Beitrag zur Gerschte und Anatomie des Pancreas. Inaug. Diss., Basil, 1893, p. 50 (Annular Pancreas).
- BALDWIN, W. M.: Anat. Record, 1910, IV, 299 (Annular Pancreas).
- CROUSE, H.: Chronic duodenal dilatation. Archiv. Surg., Nov., 1920, p. 538; also Texas State Med., March, 1920.
- COLE, L. G.: Veils in right hypochondrium and their differentiation from other organic lesions and spasm. Am. Jour. Roentgenol. and Rad. Ther., 1922, IX, 137.
- CASH, S. L.: Personal communications.
- CRYMBLE: Muscles of Treitz and plica-duodeno-jejunalis. Brit. Med. Jour., Oct. 5, 1910, p. 1156.
- CAVAZZANI, E.: Duodenal diabetes of Pfleger. Centralbl. f. Physiol., 1908, XXII, 370.
- CORDES, E.: Ein Fall von ring formigen Pancreas. Anat. Anz., 1911, XXXIX, No. 23 (Annular Pancreas).
- CODMAN, E. A.: Chronic obstruction of duodenum by root of mesentery. Boston Med. and Surg. Jour., 1908, CLVIII, 503.
- COFFEY, R. C.: Significance of fixation of certain abdominal organs in human body. Jour. Am. Med. Assn., Nov. 20, 1915, LXV, 1809.
- CHILADITI, D.: Les Plises du Duodenum. Bull. et Mem. de la Soc. de Radiol. Med., Paris, 1911, III, 43.
- DWIGHT, THOMAS: Notes on duodenum and pylorus. Jour. Anat. and Phys., 1897.
- DUVAL, P., ROUX, J. C., and BECKER, H.: Etudes Médico-Radio-Chirurgicales sur le Duodenum. Nassen et Cie, Paris, 1924.
- DUVAL, P.: Arch. d. mal. de l'app. digest., Paris, March, 1924, XIV, 197.
- DUVAL, P., and ROUX, J. C.: Duodenal migraine. Arch. de mal. de l'app. digest., Paris, January, 1924, XIV, 74.
- DUVAL, P., and ROUX, J. C.: Crises of diarrhea in duodenal stenosis. Arch. de mal. de l'app. digest., Paris, December, 1923, XIII, 996.
- ECKERSDORF: Chronisches Suprapapillares Duodenal-Geschurei U. S. U. Muenchen. med. Wehnshr., 1906, p. 2125.
- EASTMAN: Jour. Am. Med. Assn., 1913, LXI, 635.
- EISENPRATH: Ann. Surg., 1914, LX, 622.
- EHRMANN, R.: Archiv. f. d. ges. Physiol., 1907, CXIX, 195 (Duodenal Diabetes); also 1908, p. 247 (Duodenal Diabetes).
- EICHLER, L., and SILBERGLEIT, H.: Berliner klin. Wehnshr., June, 1908, p. 1172 (Duodenal Diabetes).
- ECKER, HENLE, and PFEUFER: Ztschr. f. Rationelle Med., 1862, XIV, 354 (Annular Pancreas).
- FINNEY, J. M. S.: Relation of dilatation of duodenum to gastric disturbances. Johns Hopkins Hosp. Bull., 1906, p. 37.
- FAUCET and BLATCHFORD: Observations on line at which lower border of third portion of duodenum crosses vertebral column. Jour. Anat. and Phys., London, 1903, XXXVIII, 435.
- FLINT: Johns Hopkins Hosp. Bull., 1912, XXIII, 302.
- FREEMAN: Congenital anomaly of duodenum and its surgical significance. Surg., Gynec. and Obst., 1920, XXX, 454.
- GRAY and ANDERSON: Abnormal intra-abdominal developmental adhesions. Lancet, 1913, I, 1300.
- GERSTER, A.: Ann. Surg., 1911, LIV, 325; also 1912, LVI, 583.
- GENERICH: Verhandlung des internationalen medicinischen Congress, Berlin, 1891, II, 3 ablle., 140-144 (Annular Pancreas).
- GLINSKI: Virchow's Archiv., 1901, 164 (Accessory Pancreas).
- GAUTLIER, R.: Soc. de Biol., 1908, LXIV, 358 (Duodenal Diabetes).
- HAMANN, C. A.: Faulty rotation of intestine. Ann. Surg., 1922, LXXXVI, 491.
- HERTZLER, A.: Jour. Am. Med. Assn., 1910, LIV, 351.
- HERLITZKA, A.: Archiv. Italiennes de Biol., 1908, p. 22 (Duodenal Diabetes).
- HARMAN, N. B.: Duodeno-jejunal flexure, its variations and their significance. Jour. Anat. and Phys., 1897-8, p. 665.
- HUSCHKE: Eneyelopedia Anatomique, Paris, 1845, V.
- HALPERT, BELA: Artero-mesenteric occlusion of duodenum. Johns Hopkins Hosp. Bull., June, 1926, XXXVIII, No. 6, p. 409.
- HIGGINS, C. C.: Chronic duodenal ileus. Archiv. Surg., 1926, XIII, 1.
- HARVEY, S. C.: Congenital variations in peritoneal relations of ascending colon, cecum, appendix and terminal ileum. Ann. Surg., January, 1918, LXVII.
- HOMANS, JOHN: Study of symptoms and treatment of congenital transduodenal bands. Boston Med. and Surg. Jour., Nov. 9, 1916, CLXXV, 665.
- HAYES, WILLIAM VAN V.: Intestinal stasis. N. Y. Med. Jour., Jan. 24, 1914.
- HARRIS, M. L.: Constriction of duodenum due to abnormal folds of anterior mesogastrium. Jour. Am. Med. Assn., 1914, LXII, 1211.
- HUNTINGTON: Anatomy of Peritoneum and Abdominal Cavity. 1903.

- HUET, P.: *Pancreas Annulare*. Thèse Bordeaux, 1913, No. 113.
- JENNESCO: *Sur l'Anatomie Topographique du Duodenum*. Progrès méd., Paris, 1889, 2 S. IX, 176.
- JACKSON, J. W.: *Membranous pericolicitis*. Surg., Gynec. and Obst., Sept., 1909, p. 278.
- KELLOGG, E. L.: *Treatment of gastroptosis*. Internat. Jour. Surg., Dec., 1912, p. 386.
- IDEM: *Diagnosis and treatment of chronic duodenal obstruction*. Surg., Gynec. and Obst., Feb., 1918, p. 178.
- KELLOGG, E. L. and W. A.: *Chronic duodenal obstruction, with duodeno-jejunostomy as method of treatment*. Ann. Surg., May, 1921, p. 578.
- KIEK, T. S.: *Note on duodenal ileus*. Med. Press and Circular, 1924, N. C. Vol. 97, p. 339.
- KEHR: *Über Duodenalgescwüre*. Muenchen. med. Wehnsehr., 1912, pp. 1307 u. 1380.
- IDEM: *Chirurg der Gallenwege*. Neue Deutsch. Chir., Stuttgart, Erike 1913, VIII, 8.
- KERLEY, C. G.: *Recognition and symptomatology of enteroptosis in children*. N. Y. Med. Jour., Oct., 1921.
- KOLLMAN, J.: *Hand Atlas der Entwicklungs-geschichte d. München*. Jena, Fischer, 1907.
- LANE, W. A.: *Duodenum in chronic intestinal stasis*. Surg., Gynec. and Obst., March, 1911.
- IDEM: *Kinks in chronic intestinal stasis*. Brit. Med. Jour., April 22, 1911; also Med. Press and Circ., 1913, XCVI, 522; Practitioner, 1914, XCII, 301.
- LEVEUF, J.: *Rec. de Chir.*, XLIX, 33.
- LANEREAUX: *Bull. de l'Acad. de Med.*, 1877 (*Duodenal Diabetes*).
- LANZ: *In Wullstein-Wilme Lehrt. d. Chir.* 3, Vol. II, p. 85.
- LAUWENS, R.: *Archiv. f. d. gesamte Physiol.*, 1907, CXN, 623 (*Duodenal Diabetes*).
- LECEO, F. M.: *Pancreas annulare*. Wien. klin. Wehnsehr., Jahrb. XXIII.
- McKENTY, J.: *Chronic duodenal stenosis*. Surg., Gynec. and Obst., 1924, XXXVIII, 444.
- MOLLISON and CAMERON: *Guy's Hosp. Rep.*, 1908, LXII, 143.
- MAYO, W. J.: *Am. Jour. Med. Sci.*, 1913, CXLV, 157.
- MAGAREY, A. CAMPBELL: *Australian Med. Gaz.*, Oct., 1913, No. 458, XXXIV, No. 17, p. 381.
- MELCHIOR: *Surgery of Duodenum*.
- MORRIS, R. L.: *Gall spider cases*. Am. Med., July 15, 1905, N, 95.
- MOYNIHAN, B. G.: *Disappointments after gastro-enterostomy*. Brit. Med. Jour., 1919, II, 33.
- MORLEY, J.: *Lancet*, 1913, II, 1685; also Brit. Med. Jour., 1914, II, 467.
- MINKOWSKI: *Archiv. f. exper. Path. u. Pharmacol.*, LVIII, 271 (*Duodenal Diabetes*).
- NAGEL: *Etiology and importance of cysto-duodenocolic fold*. Surg., Gynec. and Obst., 1923, XXXVII, 365.
- OCHSNER, A. J.: *Am. Jour. Med. Sci.*, July, 1906, p. 132.
- OPPEL, W. A.: *Periduodenitis*. Wratschebraja Gasetta, 1914, No. 13.
- PFLUGER, E.: *Archiv. f. d. gesamte Physiol.*, 1908, CXIX, p. 248; also CXXII, 267 (*Duodenal Diabetes*).
- QUIMBY, A. J.: *Roentgen interpretation of intestinal conditions*. Am. Jour. Roentgenol., Sept., 1914, N. S. I, 399.
- QUAIN, E. P.: *Ptoisis of third portion of duodenum, with obstruction of duodeno-jejunal junction*. Ann. Surg., Nov., 1920.
- REID, D.: *Jour. Anat. and Physiol.*, 1910-11, XLV, 73; 1912-13, XLVI, 255, 268, 486; 1913-14, XLVIII, 432; 1914-15, XLIX, 274.
- RUBIN, I.: *Surg., Gynec. and Obst.*, 1911, XII, 117.
- RIEDL: *Über Adhaswentzündungen in der Baurhpohle*. Langenbeck's Arch., 1894, B 47, p. 153.
- ROSENBERG: *Archiv. f. d. ges. Physiol.*, 1908, 4, CXXI, 358 (*Duodenal Diabetes*).
- SUSLOW: *Neue deutsch. Chir.*, 1913, VIII, 9.
- SCHUMACHER, E. D.: *Zur Duodenum Chirurgie*. Bruns' Beitr., 1910, 71, p. 482.
- SCHLECHT, H.: *Symptoms of duodenal stenosis in presence of hepato-colic ligament*. Muenchen. med. Wehnsehr., 1916, Vol. 63², p. 1353.
- SUMMERS: *Ann. Surg.*, 1914, LIX, 848.
- SILBERMAN, O.: *Jahrb. f. Kindesch.*, 1882, XVIII, 420.
- SYMINGTON: *Jour. Anat. and Physiol.*, 1885, LXIX, 292 (*Annular Pancreas*).
- TAYLOR, A. S.: *Anomalous abdominal membranes*. Ann. Surg., May, 1922.
- TAYLOR, A. S.: *Abdominal neurasthenia*. Archiv. Neurol. and Psychiat., Dec., 1920, IV, 638.
- TESTUT, L.: *Precis. Atlas de Dissection des Regions*. Paris, Doin. 1921, 251.
- TOLDT, H.: *Atlas Human Anatomy*. Relman, 1919, III and IV.
- TICKEN: *Jour. Chicago Path. Soc.*, 1899, 4, 180 (*Annular Pancreas*).
- VERBRYCKE, J. R., JR.: *Chronic duodenal stasis*. Southern Med. Jour., Sept., 1924, XVII, 653.
- VANDERHOOF, D.: *Dilated duodenum*. Jour. Am. Med. Assn., 1917, p. 510.
- VIRCHOW, R.: *Historisches Krilesches und Positivio zur Lehr. du Unterleibräffiktionen*. Arch. f. Path. Anat., 1853, 281.
- WILKIE, D. P. D.: *Chronic duodenal ileus*. Brit. Jour. Surg., London, 1922, p. 1219.
- WEISS, A.: *Le Duodeno-jejunostomie Appliqué à Trente-quatre cas de Sténose Chronique sous-Vatérienne du Duodenum. Resultas éloignés de l'intervention*. Arch. de med. de l'app. digestif., XV, 318.
- YEATS: *Some observations of duodenum, with plates descriptive of situation and connections*. Jour. Col. Phys., London, 1820, VI, 325.
- ZAK, E.: *Wien. klin. Wehnsehr.*, 1908, XX, 82 (*Duodenal Diabetes*).

CHRONIC DUODENAL OBSTRUCTION¹

By JOHN A. WOLFER, M.D., Associate Professor of Surgery,
Northwestern University Medical School, CHICAGO

A STUDY of medical literature and hospital records would indicate that chronic duodenal obstruction is rarely recognized or even suspected. Surgeons of wide experience report that they have never seen a case. That such a condition may exist is beyond doubt and that a positive diagnosis can usually be made, pre-operatively, must be conceded. I believe that when more cases have been studied and reported, then the medical profession will become acquainted with this pathologic entity and keep it in mind when confronted with a patient who presents definite and persistent dyspeptic symptoms associated with vague physical findings.

From the surgeon's point of view, certain phases of chronic duodenal obstruction are of paramount importance. A pre-operative recognition of this condition is necessary for the surgeon if he is to apply efficient and rational treatment. The diagnosis may be extremely difficult unless there is marked duodenal dilatation and we know that under certain conditions little if any dilatation is present. Under these circumstances the diagnosis may be difficult for the surgeon even after the abdomen has been opened. It is by no means an easy matter to judge the size, shape, and character of the duodenum, due to the inaccessibility of the organ and its rather firm posterior fixation. It is, therefore, not surprising that the obstruction may be overlooked even by the most competent surgeon if a pre-operative diagnosis has not been made or suggested.

Gastro-intestinal symptomatology as produced by visceral pathology is extremely confusing, due to the fact that we do not know the mechanism of its production. We all know the difficulties encountered in the

differential diagnosis of such well-known conditions as ulcer, gall-bladder and colonic disease. It is, therefore, not surprising that chronic duodenal obstruction offers difficulty in its detection.

Due to the fact that epigastric distress or pain, followed by vomiting and relief, is the common subjective symptomatology and that gastric retention may be found by fluoroscopic examination, the usual diagnosis is pyloric obstruction. A gastro-enterostomy does not relieve the symptoms; in fact, if a pyloric occlusion is not done, the symptoms will be aggravated. In the absence of gastric retention the usual diagnosis is gall-bladder disease or peptic ulcer.

In the presence of chronic duodenal obstruction, when the pyloric sphincter is tonic it prevents the regurgitation of duodenal contents into the stomach. This leads to epigastric distress or pain. During the period of pyloric hypertonicity or spasm, a fluoroscopic examination will show either an enlarged duodenal shadow or duodenal retention, depending on whether the duodenum has dilated or its walls are thickened and spastic. This pyloric hypertonicity or spasm is, no doubt, due to duodenal irritation. Very soon the pyloric sphincter will relax and allow a reflux of duodenal contents into the stomach. This may be followed by relief of pain or by vomiting and relief. It appears that sooner or later the pylorus remains patulous, allowing ready and continuous reflux of duodenal contents into the stomach, with persistent vomiting. This condition is exemplified by Whitacre's case of duodenal obstruction in which the stomach and duodenum were markedly dilated, the jejunum being collapsed, the line of demarcation being where the mesenteric vessels passed over the duodenum. A pa-

¹Read before the Radiological Society of North America, at Milwaukee, Nov. 29-Dec. 4, 1926.

tient recently under my observation complained of painful wave-like contractions in the epigastrium. Frequently they would disappear when he lay on his side. A carefully conducted study with the fluoroscope revealed the opaque material to be passing through the pylorus and distending the second part of the duodenum, no material entering the jejunum. When the duodenum was well distended the patient would complain of severe epigastric pain. Rather suddenly the pylorus would relax and there would be a sudden reflux of the material into the stomach, with immediate relief of pain. This was observed a number of times, but, unfortunately, when the plates were taken the cycle was missed in each instance. This patient had a positive Wassermann reaction and under anti-syphilitic treatment markedly improved. I believe that with careful and persistent study by the internist and radiologist, with the condition in mind, many of these cases can be diagnosed.

After a diagnosis of duodenal obstruction has been made, further efforts should be put forth to establish the possible cause. Here, again, the internist and radiologist may aid the surgeon. A history dating back to infancy may suggest the possibility of a congenital factor. The effect of posture would suggest ptosis and arterio-mesenteric occlusion. This latter condition can be demonstrated at times in an upright position, while, with the patient reclining on the table, it may be next to impossible. The presence of tumor, such as carcinoma of the stomach with secondary invasion of the duodeno-jejunal angle, or tumors involving the head of the pancreas, may be demonstrated by fluoroscopic examination. Internal hernias should not be overlooked. Eusterman recently reported 15 cases of primary carcinoma of the duodenum. Whitacre reported two cases in which omental bands obstructed the duodenum. Syphilis may play a rôle in the production of obstruction of the duodenum as in other portions of the alimentary tract.

The general condition of the patient should be carefully studied as in many instances these patients are dehydrated and a high degree of toxemia may be present. This toxemia has been the cause of much study and speculation and I believe I am correct in stating that at the present time its nature is still awaiting a solution. Dragstedt has shown that if the duodenum be suddenly occluded, the experimental animal will die within 48 hours. If a partial occlusion with a rubber band be established, the animal will also die, while if a similar occlusion be established in the ileum, no symptoms will be experienced. These experiments would indicate that duodenal obstruction is associated with a profound toxemia and that a comparatively low-grade occlusion, if suddenly applied, may produce violent reactions.

This peculiar type of duodenal toxemia, which is increased by vomiting, is associated with marked dehydration, shock, and tetany-like attacks. The chemical blood picture is characteristic. There is an increase in the blood urea, a decrease in the chlorides, and a rise in the carbon dioxide combining power of the blood plasma leading to an alkalosis. These chemical characteristics of the blood should guide us in applying rational therapy and clearly indicate that alkaline medication is not only contra-indicated but harmful. This toxemia markedly increases the operative hazards and to a degree indicates the form of treatment, either medical or surgical, that should be instituted.

So far as the surgical treatment is concerned, these cases can be divided into two groups: the dehydrated, toxic cases and those cases of chronic obstruction in which the patient is in fairly good general condition—the toxemia being low-grade. It is well to realize that a patient may tolerate a rather high grade of obstruction and remain in relatively good physical condition, yet a sudden anatomical accident may cause an acute exacerbation, characterized by a severe degree of toxemia. These patients are

extremely ill and will tolerate but little surgical interference. In this type the best results can be obtained by duodenal lavage by means of a Rehfuß tube or a jejunostomy, which allows feeding and the administration of large quantities of liquids. Any further operative measures at this time invariably lead to disaster. The intravenous administration of glucose solution is a valuable aid. Insulin may be used if necessary to control the blood sugar. A few years ago, Dragstedt introduced the so-called detoxication treatment, which consists of giving 500 c.c. of Ringer's solution intravenously every four hours for 24 to 36 hours. This results in the passage of large quantities of urine, thereby washing out the toxins and possibly establishing to some degree the chemical balance of the blood. I have tried this procedure in a few cases of obstruction and the results have been most striking, but it must be remembered that this is advocated only for the relief of the toxemia and not to supplant surgical interference. Recently, Haden and Orr have advocated the use of sodium chloride intravenously to replace the blood chlorides, which are deficient in this type of toxemia. This is a valuable and often life-saving measure. There is no question in my mind but that an apparently hopeless case can be put in relatively good shape for operation by employing some of these measures.

In the second type of case, the operation, if possible, should be directed toward the removal of the cause. If a definite band of adhesions produces the obstruction, the division of this will bring relief, as it does elsewhere in the intestinal tract. The removal of a tumor which may cause pressure, or cholecystectomy, in case the adherent gall bladder is obstructing the duodenum, should be resorted to. In a case recently under my observation, a diagnosis of high-grade duodenal obstruction was made. I believed it to be a duodeno-jejunal occlusion

due to carcinoma of the stomach which had infiltrated into this region. This diagnosis was verified on the operating table and since the causative factor could not be removed, I did a duodeno-jejunostomy. Bloodgood has called attention to the association of arterio-mesenteric duodenal occlusion with prolapse of the cecum. He believes that in the presence of a short mesentery of the lower ileum, the dilated and ptosed cecum causes traction on the mesentery, thus producing the obstruction. In consequence thereof he advocates resection of the cecum and ascending colon. In some four or five cases in which he instituted this form of treatment, his results were very good. To me, it would seem that such a radical procedure may be justifiable in a few selected cases in the hands of an extremely competent surgeon, but in the hands of the average surgeon the mortality rate would be prohibitive.

Numerous operative procedures have been advocated for the cure of arterio-mesenteric duodenal occlusion. Most of these appear to be without merit. Suspension of the ptosed viscera is uniformly unsuccessful; therefore, the suspension of the stomach, jejunum, or colon for the cure of arterio-mesenteric duodenal occlusion will be without lasting benefit. Slitting the mesentery has been suggested, but this seems to me to be but a makeshift. Section of the duodenum with reunion anterior to the mesenteric root has also been advocated. In 1907, Bloodgood suggested duodeno-jejunostomy. This operation has been performed in a large series of cases and it appears to me to be the operation of choice in the majority of cases of duodenal occlusion. In 1921, Kellogg and Kellogg reported 41 cases of their own in which this operation had been performed. There was no death from the operation and the results were excellent. Quain reports 16 cases in which he performed duodeno-jejunostomy, with no mortality. Two of these cases showed no im-

provement but he attributes the failure to massive and extensive adhesions. Recently Stincer, of Havana, reported five cases in which he performed duodeno-jejunostomy for duodenal occlusion, with equally good results.

This operation has more technical difficulties than gastro-enterostomy yet it should offer no unusual obstacles. The duodenum, especially if dilated, is readily accessible, and through a slit in the mesentery can be anastomosed to the loop of the jejunum as in performing a gastro-enterostomy. Care should be exercised when slitting the mesentery to avoid the right colic artery. The loop of the jejunum should be long enough to provide for retraction of the duodenum if it is dilated. This operation affords immediate and permanent drainage of the duodenum.

I should like to call your attention to the type of obstruction which leads to dilatation of the duodenum and part of the jejunum, that occasionally follows gastro-enterostomy. This is caused either by using too short a loop—which leads to angulation at the duodeno-jejunal angle—or to constriction of the gut by the transverse mesocolon in the posterior operation. The resultant symptoms are at times most distressing and require operative treatment. Through the courtesy of Dr. J. R. Buchbinder, I recently saw such a case. The patient was practically moribund when she came under his care, a typical picture of duodenal obstruction with high-grade toxemia. At operation, the stomach and duodenum were markedly dilated; the pylorus was relaxed sufficiently to have allowed the passage of a hen's egg. The surgeon who had performed the gastro-

enterostomy had sutured the transverse mesocolon to the gut some distance below the anastomosis. The compression of the mesocolon led to the obstruction.

SUMMARY

The pertinent facts in the surgical aspect of duodenal obstruction are:

1. A positive or tentative diagnosis should be made before an operation is performed.
2. A causative factor, if possible, should be determined before operation.
3. In the acute cases, the treatment should be directed toward detoxication and fluid and nutritional replacement.
4. The causative pathologic factor should be removed; if this is not readily possible, then duodeno-jejunostomy is the operation of choice.

REFERENCES

- BLOODGOOD, J. C.: Acute dilatation of the stomach, Gastro-mesenteric ileus. *Ann. Surg.*, XLVI, 736. Dilatation of the duodenum in relation to the surgery of the stomach and colon. *Jour. Am. Med. Assn.*, LIX, 117.
- DRAGSTEDT, L. R., and C. A.: Acute dilatation of the stomach. *Jour. Am. Med. Assn.*, LXXIX, 612-615.
- EUSTERMAN, BERKMAN, and SWAN: Primary carcinoma of the duodenum. *Ann. Surg.*, LXXXII, 153-163.
- HADEN and ORR: The effect of sodium chloride on the chemical changes in the blood of the dog after pyloric and intestinal obstruction. *Jour. Exper. Med.*, XXXVIII, 55-71.
- KELLOGG and KELLOGG: Chronic duodenal obstruction, with duodeno-jejunostomy as a method of treatment. *Ann. Surg.*, LXXIII, 578.
- QUAIN, E. P.: Chronic duodenal obstruction. *N. Y. Med. Jour.*, CXVI, 651-654.
- STINCER, E.: Chronic stenosis of the duodenum. *Rev. de med. y cirug. de la Habana*, XXX, 323-348.
- WHITACRE: Chronic duodenal obstruction. *North-west Med.*, XXIV, 113-115.

CHRONIC OBSTRUCTION OF THE DUODENUM¹

By WILLIAM H. HOLMES, M.D., Associate Professor of Medicine, Northwestern University Medical School; Attending Physician, Wesley Memorial Hospital, CHICAGO

OBSTRUCTION of the duodenum may be congenital or it may occur acutely or develop slowly. The acute form often follows abdominal operations and is then known as acute dilatation of the stomach. Surgeons of experience are well acquainted with this dread complication. The almost continuous vomiting which accompanies it results in a loss of water and salts, and this, with the associated intoxication, quickly reduces the patient to a critical condition. For these reasons this form of obstruction has been studied very carefully.

The chronic form of obstruction has a less dramatic onset and the possibility of its existence is seldom suspected, even by men of wide experience. It has been described under a variety of titles, such as dilated duodenum, stenosis of the duodenum, duodeno-jejunal ileus, arterio-mesenteric duodenal occlusion, megaduodenum and others. Of these, the least satisfactory titles are those which imply that dilatation of the duodenum is an invariable accompaniment of duodenal obstruction. If that were true the diagnosis would be comparatively simple. Any dilatation of the duodenum which occurs as a result of chronic obstruction develops gradually, and there must, therefore, be various stages in its development, from slight delay in emptying of the duodenum to more or less complete obstruction, with tremendous dilatation. The degree of obstruction is not the only factor involved in determining the amount of dilatation. It is obvious that the resistance of the pylorus to retrograde peristaltic movements, the tone of the gastric and duodenal musculature, and the rate at which the obstruction

develops are also important factors. Use of the term "chronic obstruction of the duodenum" seems unobjectionable since it neither implies that dilatation exists nor restricts the use of additional descriptive terms.

The causes of chronic obstruction are varied. It may be caused by intraduodenal pathology but it is more frequently the result of disease in adjacent viscera. Angulation, adhesions, stenosis, pressure by tumors or inflammatory masses, infiltration, pancreatitis, cholecystitis, and constriction by the root of the mesentery have been described by various observers as occasional causes of chronic obstruction. Jordan (1) describes a type of obstruction due to a kink at the duodeno-jejunal flexure. It is his belief that a kink at the duodeno-jejunal flexure may occur, because the third part of the duodenum is normally firmly fixed over a peritoneal band while the jejunum is unsupported at its commencement. A case of obstruction due to angulation caused by adhesions was observed by Anders (2). Albert J. Ochsner (3) has reported fourteen cases of duodenal obstruction, with dilatation in twelve. In eleven, a pathological gall bladder was found; in one case the duodenum was adherent to the liver and in another there was evidence of ulcer. This is an observation of some importance. The symptoms of gall-bladder disease and of chronic duodenal obstruction are very similar and the differential diagnosis correspondingly difficult. That the two conditions were associated in 78.6 per cent of Ochsner's cases of obstruction may explain why gall-bladder surgery is not invariably successful. One of the cases of obstruction seen by me had had a cholecystectomy some

¹Read before the Radiological Society of North America, at Milwaukee, Nov. 29-Dec. 4, 1926.

years previously without relief of her symptoms. The records of the hospital in which the operation was performed show that the gall bladder was perfectly normal and that no other pathology was found. This would indicate that an arterio-mesenteric obstruction easily demonstrable at the present time was the cause of the symptoms attributed to the gall bladder. The formation of adhesions is not the only complication of gall-bladder disease capable of causing obstruction. A cholecystectomy performed on one of my patients was followed by an acute pancreatitis. The swelling and edema of the pancreas caused an acute duodenal obstruction, which persisted for several days, and subsided with the return of normal pancreatic function. In another case, a posterior gastro-enterostomy was followed by an acute obstruction caused by herniation of the duodenum through the opening in the mesocolon. The herniation was reduced and the obstruction relieved, but this second operation was again followed by obstruction. At the time of the third abdominal operation, within a period of ten days, it was found that the obstruction was caused by an acute pancreatitis with tremendous edema of the mesentery and omentum. The obstruction lasted twenty-one days, during which period from four to eight liters of fluid were aspirated every twenty-four hours. A case of chronic obstruction with dilatation due to herniation of the duodenum following gastro-enterostomy was seen recently on the service of one of my associates. Wolfer has had a case of duodenal obstruction with marked duodenal dilatation as a result of angulation caused by linitis plastica. It is evident, therefore, that almost any inflammatory or malignant condition in the upper abdomen may result in duodenal obstruction.

Many investigators believe that under certain conditions chronic incomplete obstruction of the duodenum may be caused by

pressure of the root of the mesentery as it crosses the third part of the duodenum. Others, however, deny this possibility. For my own part I may say that I have a number of patients whose symptoms, physical and X-ray findings are inexplicable except by this hypothesis. This form of obstruction is often associated with visceroptosis and cecal retention. Barber (4) regards the obstruction as secondary to dilatation of the cecum caused by chronic constipation. Bloodgood (5) observed great dilatation of the duodenum in five of twenty cases in which he resected the colon. He says, "The constriction at the root of the mesentery is due to a pull on the mesentery by the dilated cecum displaced into the pelvis." He further states, "These patients have been relieved after resection of the right half of the colon." Dilatation of the cecum is common and yet associated evidence of duodenal obstruction is relatively uncommon. With reference, no doubt, to this point, Bloodgood says that, "the mesentery of the portion of ileum near the cecum is short. When the mesentery is long the redundant cecum cannot produce this pull." On the basis of anatomical studies Codman (6) states that "in the human being the transverse portion of the duodenum is more or less compressed by the root of the mesentery" and also that "in the erect position the lumen of the gut must be a vertical slit compressed in proportion to the weight of more or less of the intestine."

Because of complications from right coloptosis Quain (7) found it necessary to do five duodeno-jejunostomies in a series of seventy cases in which fixation of the colon to the muscles of the back was also performed. He says, "When the entire right colon is free and hanging by its mesentery, traction is exerted across the second and third portions of the duodenum. . . . The variety of symptoms that may be produced in the gall bladder, duodenum, and

stomach is enough to cause serious confusion in the diagnosis of cholecystitis and duodenal or gastric ulcer."

It is thus seen that the possibility of arterio-mesenteric obstruction of the duodenum as a complication of visceroptosis, but particularly of right coloptosis with dilatation of the cecum, is supported by numerous competent observers. The anatomical condition which permits compression of the duodenum is due to the fact that the superior mesenteric artery arises from the aorta behind the pancreas and descends in front of the third part of the duodenum. It then enters the root of the mesentery which extends from the left side of the second lumbar vertebra to the right iliac fossa. The line of attachment is only about six or seven inches in length. To accommodate the intestines the mesentery spreads out in a fan-shaped manner. I have satisfied myself, by placing a finger in the third part of the duodenum, that traction on the mesentery will produce compression of the duodenum which lies between it and the aorta and vertebral column.

The incidence of chronic duodenal obstruction of the arterio-mesenteric type is unknown. It probably occurs more frequently than it is recognized, the symptoms being attributed to gall-bladder disease, ulcer, or regarded as a neurosis, a diagnosis which curiously enough is perfectly acceptable to many of those who deny the clinical importance of visceroptosis, coloptosis, and cecal stasis. Engelbach (8) believes that arterio-mesenteric obstruction is being overlooked and treated as other conditions and that those who are acquainted with the syndrome invariably admit that the first case was recognized either at autopsy or operation.

The symptoms of chronic duodenal obstruction are those of chronic dyspepsia. There may be pain in the epigastrium or in

the right hypochondrium or in both these locations. It is usually relieved by vomiting and is often relieved by changes in position. The prone position may give relief by releasing pressure on the duodenum. Unlike the pain of ulcer it is not relieved by food. It is described as a diffuse, full, dragging sensation. Vomiting of bile and gastric secretions occurs in proportion to the degree and duration of the obstruction. In a case already referred to, 8,230 c.c. of fluid was aspirated in one 24-hour period. In some cases vomiting occurs daily while in others it is periodic. Constipation is almost invariable, irrespective of the cause of the obstruction. Vague toxic symptoms, such as headache, vertigo, nervousness, insomnia, emotional instability, and syncopal attacks occur.

In experimental obstruction of the jejunum, Haden and Orr (9) found constant changes in the blood of the dog. Every animal showed a fall in blood chlorides and many showed an increased carbon dioxide combining power of the plasma. In most cases there was a rise in urea nitrogen and non-protein nitrogen. Complete obstruction in clinical cases is characterized by the same findings, but I am not acquainted with any blood chemistry studies in incomplete obstruction. It is, however, very probable that any degree of obstruction capable of giving rise to pain and vomiting will be associated with chemical changes in the blood, although they may not be great enough to possess diagnostic value.

It is apparent that the clinical symptoms are not sufficiently characteristic to permit a positive diagnosis without the aid of X-ray examination. The technic and findings of such an examination do not come properly within the scope of this paper.

The treatment of chronic duodenal obstruction is both medical and surgical. If the patient belongs to the visceroptotic group

and the obstruction is due to traction, relief may be obtained by prolonged bed rest and over-alimentation, but the cure is not likely to be permanent. In this event fixation of the colon or fixation of the colon and duodeno-jejunostomy may be necessary. If the obstruction is caused by adhesions, bands, kinking or tumor, medical treatment becomes ancillary to surgical treatment. Blood chlorides should be maintained, the obstructed duodenum should be kept empty by repeated aspiration through a Rehfuß tube. Elimination of retained nitrogen products should be encouraged by forcing fluids. Body heat must be conserved, and needless protein breakdown avoided by decreasing muscular and mental effort. Medical treatment of complete duodenal obstruction will tax the skill and ingenuity of even the most accomplished physician.

REFERENCES

1. JORDAN, ALFRED C.: The duodenum and the appendix in intestinal stasis. *Brit. Med. Jour.*, June 1, 1912, I, 1225.
2. ANDERS, JAMES M.: Stenosis of the duodenum; a statistical study, with the report of a new case. *Am. Jour. Med. Sci.*, 1912, CXLIV, 360.
3. OCHSNER, ALBERT J.: Constriction of the duodenum below the entrance of the common duct and its relation to disease. *Ann. Surg.*, 1906, XLIII, 80.
4. BARBER, W. HOWARD: Dilatation of the duodenum; an experimental study. *Ann. Surg.*, 1915, LXII, 433.
5. BLOODGOOD, JOSEPH C.: Dilatation of the duodenum in relation to surgery of the stomach and colon. *Jour. Am. Med. Assn.*, 1912, LIX.
6. COBMAN, E. A.: Chronic obstruction of the duodenum by the root of the mesentery. *Boston Med. and Surg. Jour.*, 1908, CLVIII, 503.
7. QUAIN, E. P.: Pathogenic ptosis of the right colon. *Archiv. Surg.*, 1923, VI, 638.
8. ENGELBACH, WILLIAM: Arteriomesenteric occlusion of the duodenum. *Am. Jour. Roentgenol.*, 1918, I, 48.
9. HADEN, R. L., and ORR, T. G.: Experimental obstruction of the jejunum. *Jour. Exp. Med.*, 1925, XLI, 707.

A BRIEF REVIEW OF THE PHYSIOLOGY OF THE DUODENUM¹

By A. C. IVY, M.S., PH.D., M.D., CHICAGO

From the Department of Physiology and Pharmacology, Northwestern University Medical School

THE duodenum manifests three fundamental physiological phenomena: motility, secretion, and absorption.

MOTILITY

Speaking broadly, it can be said that the duodenum manifests under various conditions all the motor phenomena known to exist in the gastro-intestinal tract. By the use of various methods rhythmic segmentation, peristalsis, peristaltic rushes, and reversed movements have been observed.

Rhythmic Segmentation. — The occurrence of rhythmic segmentations in the duodenum is well known. They have been described in detail recently by Wheelon (1). They bring about a "to and fro" movement of the contents, which results in a thorough mixing of digestive secretions with the chyme.

Rhythmic segmentations are initiated by strictly local contact of the contents with the duodenal mucosa, and are more constantly observed in the distal than in the proximal duodenum.

Peristalsis.—The ejection of chyme or contents from the stomach into the duodenum is the most common cause of peristalsis of the duodenum. The peristalsis so initiated usually travels hastily through the entire course of the duodenum, or sometimes disappears in its second or third portion. It is quite likely that the ejection of bile and pancreatic juice into the duodenum also causes peristalsis.

The exact relation of gastric motility to duodenal motility is still a mooted question. Some hold that gastric movements end at the pyloric sphincter; others believe that at least in some cases the gastric wave of con-

traction passes down over the duodenum. Cole (2) reports that "the duodenal cap is evacuated by a broad peristaltic wave, independent of gastric peristalsis, which forces the chyme through the duodenum in 'finger-like masses.'" The observations of Luckhardt, Phillips and Carlson (3) and of Wheelon and Thomas (4) suggest that at least some of the gastric waves pass over the sphincter to the duodenum. My own observations (5, 6) on experimental animals and man lead me to believe that in the majority of instances a contraction of the duodenal cap, at least the distal portion of the cap, occurs after a brief pause following the arrival of a vigorous gastric wave at the pyloric sphincter. Every gastric wave, however, does not affect the cap; neither does every gastric wave open the pyloric sphincter. Orndoff (32) and Case (33) both believe that there is a direct relation between gastric and duodenal motility. Cunha (7), in a recent paper on the physiology of the duodenum, has stated that the gastric wave passes from the stomach over the duodenum. In acute animal preparations I have seen, and called the attention of students to, the apparent passage of waves from the stomach to the duodenum—especially true in the cat after pilocarpin administration. Alvarez (8), who holds that gastric waves stop at the pyloric sphincter, grants that some influences pass over the sphincter to start peristaltic rushes in the bowel.

In interpreting the observed facts on the relation of gastric motility to duodenal peristalsis, at least four possibilities must be considered. First, the excitatory impulse, or wave of conduction, may pass from the stomach to the duodenum without the ac-

¹Read before the Radiological Society of North America, at Milwaukee, Nov. 29-Dec. 4, 1926.

tual wave of contraction passing. Second, the relative amotility of the cap, possibly due to the anatomical arrangement and

duodenum does not manifest hunger motility.

The normal tendency towards retention

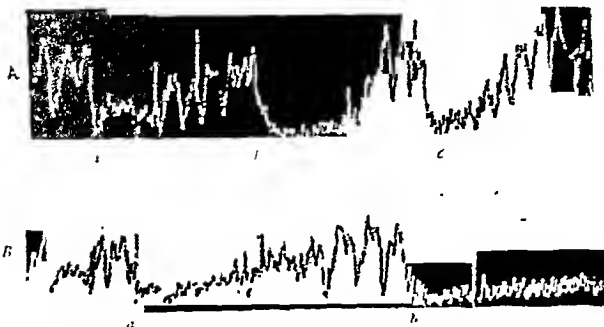


Fig. 1. Tracings of the empty stomachs of dogs. *A*, *a*, mechanical stimulation of intestinal mucosa (gently moving a rubber tube in the lumen); *b*, 10 c.c. water introduced into the intestine; *c*, 10 c.c. of 0.3 per cent Na_2CO_3 introduced into the intestines; *B*, *a*, 10 c.c. of 10 per cent peptone in 0.2 per cent HCl introduced into intestine; *b*, 10 c.c. fresh milk introduced into the intestine; showing temporary inhibition of tonus and hunger contractions of the empty stomach by mechanical and chemical stimulation of the intestinal mucosa. (After Carlson.)

physiological threshold of the relatively few contractile fibers of this portion of the duodenum, may mask the passage of the wave. Third, the threshold of the mucosa, or musculature of the cap, may be higher than the remainder of the duodenum, so that greater distention, prolonged chemical action, or a summation of local or transmitted stimuli may be necessary to cause the cap to contract. Fourth, the duodenal peristalsis may be initiated almost immediately on the ejection of chyme from the stomach, due to the mechanical or chemical stimulation of the mucosa.

A relation between the stomach and duodenum exists in hunger (6). During hunger motility of the stomach, the duodenum manifests contractions synchronous with those in the stomach with the exception that frequently the duodenal contractions lag behind those in the stomach. This leads us to believe that the gastric hunger contractions, or their effect, pass from the stomach to the duodenum. This is supported by the fact that if a pylorectomy is performed, the

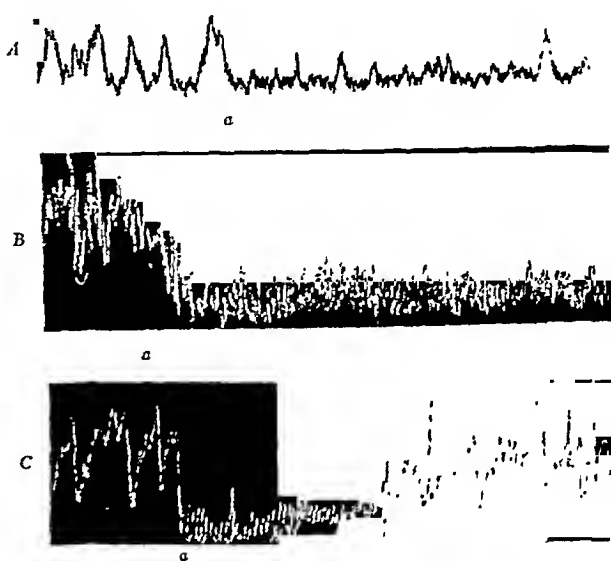


Fig. 2. Tracing shows tonus and hunger contraction of the empty stomach of dogs. *A*, 10 c.c. of gastric juice introduced into small intestine at *a*; *B*, 10 c.c. 0.5 per cent HCl introduced into small intestine at *a*; *C*, 10 c.c. 1 per cent Na_2CO_3 introduced into the small intestine at *a*; showing reflex inhibition of the tonus and the hunger contractions of the empty stomach by chemical stimulation of intestinal mucosa. (After Carlson.)

of contents in the cap is well known. The observations of Wheelon (1) direct attention to another portion of the duodenum in which a tendency toward retention exists, namely, the inferior flexure. This is commonly the lowest point of the duodenum and the peristalses must overcome the effect of gravity, lifting the contents to the fixed portion of the duodenum. The heavier the contents, *e.g.*, a barium meal, the greater would be the tendency toward retention. Any increase in extrinsic pressure on the fixed portion of the duodenum by the superior mesenteric vessels, etc., would make it still more difficult to pass contents. Hence, the tendency toward retention in the region of the inferior flexure, observed in routine radiographic examinations, is obviously significant with respect to the etiology of chronic duodenal dilatation.

The question logically arises as to how much extrinsic pressure is required to counteract the propulsive force of duodenal peri-

end-to-end anastomosis of the jejunum to the duodenum. The distal end of the resected loop was closed and the proximal or

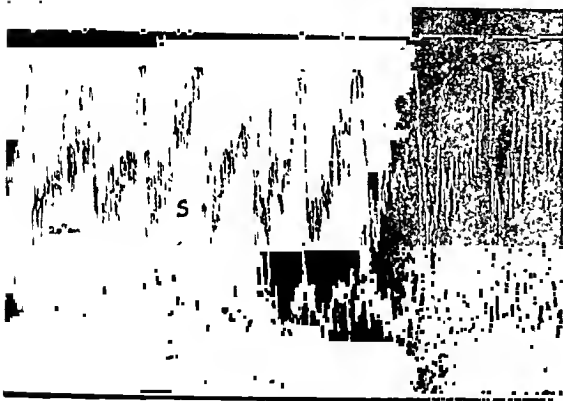


Fig. 3. Man. Contractions occur in the duodenum synchronously with hunger contractions in the stomach; the duodenal contractions sometimes, *x*, reach their height after the hunger contractions have ceased. Balloon in the first six inches of the duodenum.

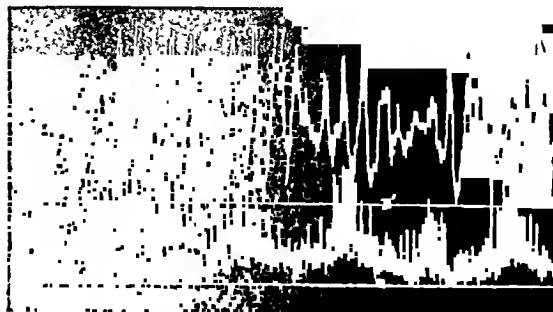


Fig. 4. Simultaneous tracing of the motility of the stomach and a Thiry's fistula of the duodenum and jejunum during hunger. *S*, stomach; *I*, Thiry's fistula. Thirty cubic centimeters of air in balloon in stomach; 10 c.c. air in balloon in fistula. Note that the rhythmic segmentations, *x*, and tonus rhythm, *a-a'*, are not correlated with the hunger contractions. *B*, base line of intestine; *B'*, base line of stomach. This shows that the motility of the duodenum during hunger is dependent on the cutic reflexes.

stalsis. The results of experiments by Dragstedt and Dragstedt (9) show that circular extrinsic pressure equivalent to six inches of water exerted by a light condom rubber band is sufficient to cause acute duodenal obstruction and death. Greater pressure is required in the jejunum, ileum, and colon. An extrinsic pressure, then, of less than six inches of water would lead to partial obstruction, with the usual concomitant phenomena of hyperperistalsis, dilatation with some hypertrophy, intermittent nausea and vomiting, and mild toxemia.

I have had the accidental opportunity to observe two examples of such a condition in experimental animals. In making a Thiry fistula of the duodenum and upper few inches of the jejunum, the duodenum was sectioned just below the opening of the chief pancreatic duct and the jejunum was sectioned eight or ten inches below the fixed portion of the duodenum. The integrity of the gut was re-established by an

duodenal end was brought to the outside through an opening in the right lateral wall of the abdomen. In our experience with more than fifty of these animals, three have died from obstruction due to the strangulation of the jejunum and ileum behind or posterior to the duodenal loop, constituting the Thiry fistula. Two other animals vomited intermittently for several months, became emaciated, and were finally anesthetized and autopsied. In these two animals it was found that small loops, eight and twelve inches long, respectively, of proximal jejunum had passed posterior to the duodenal loop, constituting the Thiry fistula, and had been fastened in this position by a few loose adhesions. When chyme passed into this loop it would have to be lifted and forced past a point of partial obstruction caused by the pressure of the weight of the loop on the Thiry fistula, there being no adhesions between the loop and fistula to cause obstruction (Figs. 6a and 6b). The loop of jeju-

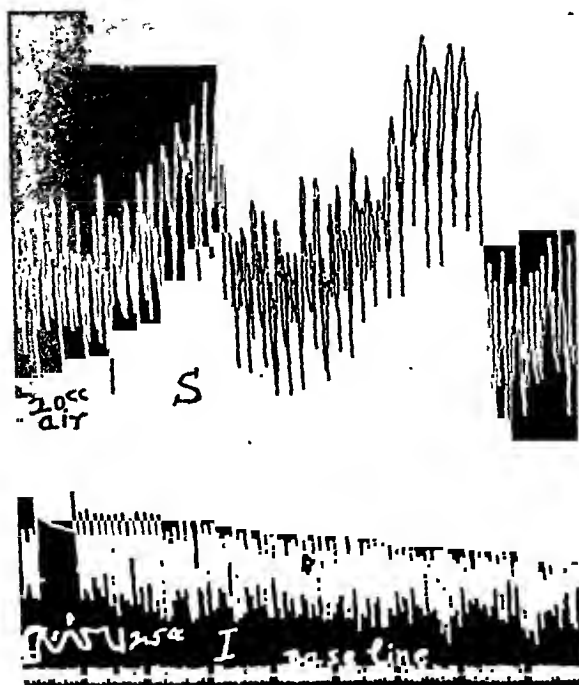


Fig. 5. Simultaneous tracings of the motility of a pouch of the entire stomach, *S*, and of the duodenum, *I*, during hunger in a dog with a duodeno-esophageal anastomosis. Note that there is no relation between the movements in the stomach and duodenum during hunger. The marked tonus shown by the stomach in this tracing is quite characteristic for animals prepared in the manner stated above. This shows that the motility of the duodenum during hunger is dependent on the enteric reflexes.

num was dilated and slightly hypertrophied; the intestine proximal and distal to the loop was normal.

In this connection our observation on the esophagus and duodenum in dogs in which a duodeno-esophageal end-to-end anastomosis has been performed proves interesting. We have had three dogs that have survived this operation, one for seven months, another for eight months; the third is now alive at two years. We have looked for dilatation and hypertrophy of the esophagus and duodenum in these animals; in the esophagus, because of the possibility of stenosis; in the duodenum, because of the tension on and the abnormal position of the duodenum. None of the animals showed any change, probably because the operation caused an immediate change in their eating

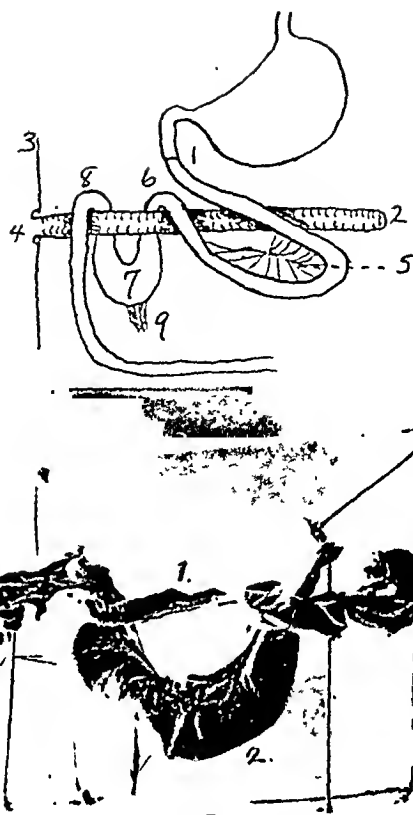


Fig. 6a. This diagram shows the findings in a dog following the making of a Thiry fistula in which a loop of jejunum herniated posterior to the fistula. (1) Site of anastomosis of proximal duodenum to jejunum. (2) The closed end of the Thiry fistula of the duodenum and first few inches of the jejunum. (3) Abdominal wall. (4) Opening of the fistula to the outside. (5) Mesentery of the jejunum, fixing the first portion of jejunum. (6) The point at which the jejunal loop passed posterior to the fistula. (7) The dilated and hypertrophied loop. (8) The point at which the jejunum passed over the fistula, there being no adhesions at this point. (9) A few light adhesions which held the herniated loop in its position.

Fig. 6b. The specimen described by the Diagram 6a. (1) The Thiry fistula. (2) The dilated loop.

habits. Instead of bolting their food, they ate slowly, taking from twelve to twenty-four hours to ingest their meal (Figs. 7a, 7b, 7c, and 8). (It is difficult to make an accurate comparison of the roentgenograms taken in December, 1924, with those taken in November, 1926, because of the irritabil-



Fig 7a Roentgenogram taken on dog with a pouch of the entire stomach and a duodeno-esophageal anastomosis in December, 1924

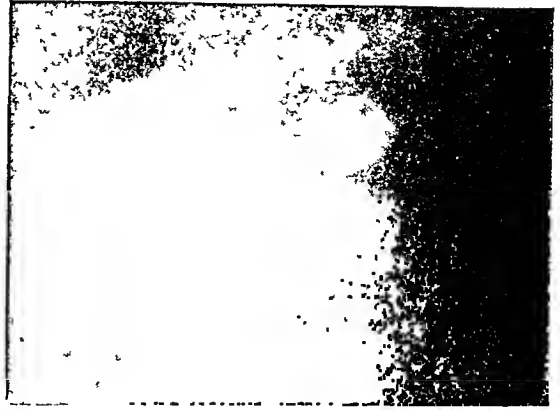


Fig 7b Roentgenogram taken on dog with a pouch of the entire stomach and a duodeno-esophageal anastomosis in December, 1924

ity of the duodenum when the pictures were made in 1924. We can only say that our interpretation of the roentgenograms does not warrant the conclusion that a dilatation has occurred. We can say, however, that the duodenum is now less irritable than it was in 1924.)

Reversed Movements.—Reversed movements of the duodenum occur under normal and abnormal conditions.

They occur normally in many individuals at the end of a meal when strong acid chyme is being ejected into the duodenum. This is a well-known fact. Such reversed motility may not only be due to enteric reflexes, but may even occur by reflexes through the celiac ganglion. For example, we (10) have found that if acid, or other mildly irritating substance, is applied to a Thiry fistula of the duodenum, bile will be regurgitated into the stomach. This regurgitation occurs in normal men when the duodenum is irritated by chemicals or by distention (5) (6) (10) (1) (11). Wheelon (1) has observed reverse movements with the fluoroscope in individuals with a normal or a shortened gastric clearance.

Reverse motility of the duodenum occurs abnormally in various conditions. Many

have observed it in vomiting. Henderson (12) has reported reverse movements to be present in 93 per cent of patients infected with hookworm. Friedman, Strauss, and Arens (13) have seen them in many patients with gall-bladder disease, and believe that they are due to an associated duodenitis. Thoring and Smith (14) observed such movements in a dilated duodenum due to obstruction from adhesions. It is now well known that they occur in cases of duodenal obstruction near the duodeno-jejunal junction. Reverse movements of the duodenum will in all probability be found to be associated with any condition that increases the irritability of the duodenal mucosa or musculature. Teleologically the duodenum apparently attempts to protect itself by regurgitating contents into the stomach.

What would be the effect of abnormal reversed movements continued for a long time—several months? This question cannot be answered directly for man. We have experiments on the dog which answer the question for the jejunum. The following experiment has been performed a number of times in one of our courses in Advanced Experimental Physiology. A four- or six-inch loop of jejunum is resected and turned end-to-end, *i.e.*, reversed, and sutured in place by an end-to-end anastomosis, so that

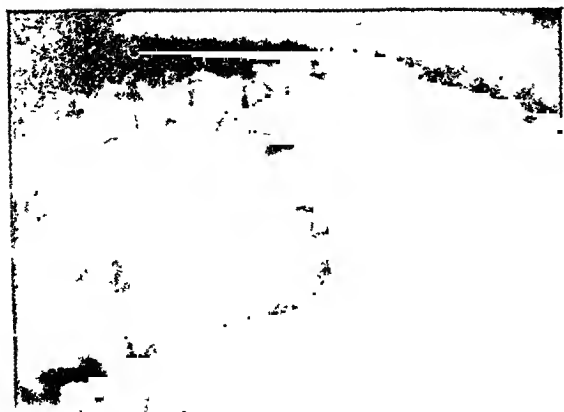


Fig 7c Roentgenogram taken on dog with a pouch of the entire stomach and a duodeno-esophageal anastomosis in December, 1924.

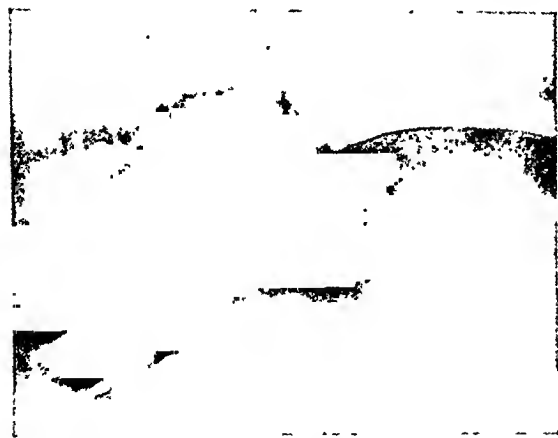


Fig. 8 Roentgenogram taken on same dog as in Figures 7a, 7b, and 7c in November, 1926. We do not believe that the roentgenograms show any evidence of dilatation. The dog is now in excellent health.

the normal direction of the peristalses in the loop is reversed so far as the remainder of the intestine is concerned. When this has been done, and the dog has survived for several months (as four have done), it is observed that the dog vomits intermittently, some have lost weight and others have maintained their body weight. Autopsy has revealed the jejunum proximal to the reversed loop to be dilated and slightly hypertrophied. Sometimes the proximal portion of the reversed loop is dilated. This "reversed loop experiment" constitutes what might be

termed a physiological partial obstruction. (If the reversed loop is made too long (8 to 10 inches), the animal dies from acute obstruction.) Although the peristalses of the reversed loop cannot be considered as true reversed movements, their physiologic effect upon the intestine above and below such a loop amounts to the same thing.

THE EFFECT OF DUODENAL STIMULATION ON THE MOTOR ACTIVITY OF OTHER PARTS OF THE GASTRO-INTESTINAL TRACT

Stomach.—Brunemeier and Carlson (15) found that stimulation of the duodenum inhibits the motility of the empty stomach, an observation which we have confirmed (6). Wheelon and Thomas (4) have observed that elevations in duodenal tone are associated with reduction of the gastric antral waves. Brickner and Milch (16) have reported that on relief of chronic duodenal stasis by duodeno-jejunostomy the peristaltic activity of the stomach increases. Although the duodenum is subject to the motor drive of the stomach, the observations just cited show that the duodenum possesses a mechanism for controlling the motor drive of the stomach.

Vomiting.—Many observers have confirmed the observation of Luckhardt, Phillips and Carlson (3, 5, 6, 10, 1, 11), that vomiting is more readily elicited from duodenal irritation than from gastric irritation. The author is able to inhibit voluntarily the vomiting impulse caused by pharyngeal and gastric irritation, but not duodenal, because of its more rapid and violent onset.

Colon.—According to our observations in dogs (10), the colon is reflexly connected with duodenal activity. When one first makes applications of acid and various substances to a Thiry fistula of the duodenum, defecation and vomiting, sometimes one or both, result.

Although we know that colon stimulation inhibits the stomach (34), we do not know definitely the effect of colon stimulation on duodenal activity. However, the writer (5) has observed in several experiments that when a water enema was taken, bile was regurgitated into the stomach.

Hiccough.—The author has on several occasions observed hiccough to occur in dogs following sudden distention of the duodenal Thiry fistula.

Biliary Passages.—The recent observations of Burget (17) and Graham (18) and his associates have shown that the tonus and motility of the duodenum plays a fundamental rôle in the passage of bile from the gall bladder and biliary passages.

In this connection it is quite possible that hypertonus, amotility, and reversed movements of the duodenum may be important etiological factors in disease of the biliary passages. A study of the duodenum in pregnancy is certainly indicated because of this possibility.

Motor Hormone.—There is no evidence worth while considering that the duodenum gives off a hormone that maintains the motor activity of the remainder of the gastrointestinal tract.

SECRETION

A Thiry fistula of the duodenum secretes continuously a small quantity (2 or 3 c.c. per hour) of fluid. If this is not drained out, the water is re-absorbed, leaving a yellow-white pasty material. The secretion contains cells and enzymes (lipase, invertase, erepsin) in small concentration, which probably come from the cells. The secretion is slightly alkaline (Ph. 7.5 - 7.8). The feeding of a meal has practically no effect on the rate of secretion of such an isolated loop. Mild distention with a balloon, manipulation with a rubber tube, or application of dilute acids, alcohol (5 to 10

per cent), fatty acids, glycerol, etc., are stimuli that definitely cause an increase in secretion. The subcutaneous injection of pilocarpin and histamin also increases the secretion. Increased motility of the loop is always associated with an increase in secretion (10) (19).

The secretion of the duodenum plays only a minor rôle in normal digestion. The intestinal secretion, taken as a whole, however, does play a definite rôle in normal digestion. This is shown by the fact that digestion, although definitely less than normal, occurs in animals deprived of their pancreas or with the pancreatic ducts ligated (19).

An overlooked, but very important, rôle of duodenal and intestinal secretion is its ability to neutralize acid. A duodeno-jejunal Thiry fistula only 15 inches long can neutralize 50 per cent of the free acid and 30 per cent of the total acid of 150 c.c. of N/10 HCl when applied for sixty minutes.

The duodenum is very intimately related to the secretion of the stomach (10) (20) and pancreas (21). Various substances, *e.g.*, acids, fatty acids, fats, glycerol, alcohol, meat extracts, etc., have a definite and fundamental action on the secretion of the stomach and pancreas when applied to the duodenal and jejunal mucosa. The jejunum, and in all probability the duodenum, gives off a hormone that excites external pancreatic secretion.

ABSORPTION

The duodenum can absorb substances from its lumen. We know that it can absorb water, glucose, alcohol, and crystalloids (KI and NaCl) quite rapidly. Because of the relatively rapid passage of contents through, and the incompleteness of digestion of food when it enters the duodenum, probably only a small amount of absorption

occurs in the duodenum during the normal digestive process.

In duodenal obstruction toxic substances pass into the circulation from the lumen, which under normal conditions does not occur, at least to no great extent (9). It is commonly stated that distention causes a disturbance, or a breakdown, in the normal processes concerned in absorption, but this is an assumption that has not yet been proved.

In pernicious anemia the hypothesis has been advanced that hemolytic and neurotoxic substances of bacterial origin are absorbed from the duodenum.

EXCRETION

There is no good evidence, not even presumptive, that the duodenum excretes any specific substance or plays any special rôle as an excretory organ.

DUODENUM IS NOT A VITAL ORGAN

Not many years ago the duodenum was thought to be a vital organ, that it performed some function necessary for life. The development of surgical skill by workers in this field has demonstrated this belief to be a fallacy. If the surgery is good, the animal gets along without the duodenum as well as it does with it (22, 23, 24).

COMPLETE OBSTRUCTION OF THE DUODENUM

In dogs, if the duodenum is completely occluded at the jejunal junction for eighteen hours, death results. If it is occluded for fifteen hours and then opened, recovery occurs (25). Surgeons and internists keenly appreciate the serious nature of duodenal obstruction.

RELATED TO BLOOD-FORMING ORGANS?

It has been suggested that the duodenum is related to iron metabolism and the formation of erythrocytes. (For a review of the literature, see Ref. No. 26.) It has been

stated that iron is absorbed in the upper gastro-intestinal tract, which is slightly acid in reaction most of the time (iron salts are soluble in acid solutions) and excreted in the lower portion of the tract. Downs and Eddy (27) have reported that secretin solution, a solution prepared by hydrochloric acid extraction of the duodenal mucosa, on injection causes an increase in red cells and hemoglobin. The interpretation of these results, however, has been questioned by King (28), who believes that the increase is only apparent and not real, being due to concentration of the blood.

The possible relation of the duodenum to the blood-forming organs is still hypothetical.

DUODENAL FLORA

Within the last few years much attention has been given to the study of the flora of the duodenum. Under normal conditions the duodenal flora is not abundant, and is quite innocent. But in achylia gastrica, anacidity, pernicious anemia, combined degeneration of the spinal cord, and in ileal stasis, the flora of the duodenum is radically changed, being similar to that of the ileum, toxin-producing bacteria being present. (For review of literature, see Ivy, Ref. No. 26.) Arnold (29) has recently shown by improved experimental methods that when the acidity of the duodenum is decreased, the flora becomes abundant and like that of the ileum.

So far as the author has been able to ascertain, no one has yet studied the flora in chronic duodenal stasis.

EFFERENT INNERVATION

The efferent innervation of the pyloric sphincter has been adequately studied, but we do not possess entirely satisfactory evidence bearing on the efferent innervation of the duodenum. The author teaches that the

vagi and splanchnics probably carry both motor and inhibitory fibers to the duodenum, the vagi, however, being predominately motor and the splanchnics predominately inhibitory.

AFFERENT INNERVATION—SENSATION

Although we do not know the path that sensory impulses from the duodenum travel, we do know that the stimulation or irritation of the duodenum causes one to experience definite sensations (6, 1, 11, 31).

Nausea is the most frequently observed symptom elicited by duodenal stimulation. The author can distinguish it from pharyngeal and gastric nausea. Pain is next in frequency of occurrence. Distention or spasm causes it. On distending a balloon when it is in the third portion of the duodenum, the author refers the sensation to the midline, one or two inches above the umbilicus, and on withdrawing the balloon pain has been felt beneath the liver on the right side. On two occasions in which violent pain was experienced, a sore spot persisted over the clavicle at the junction of the outer and middle thirds (6). Uneasiness, faintness, dragging and swaying sensations, dizziness, chilliness and pallor are other symptoms associated with duodenal irritation. The author and his associates have also observed that when a balloon or tube has been in the duodenum for twelve or twenty-four hours and then removed an "after image" results, *i.e.*, one has a sensation as if the balloon were still in the duodenum. A frontal headache occurs in some individuals on duodenal experimentation (6).

Alvarez (30) has suggested that the nausea and vomiting is due to reversed movements. The observations of Wheelon (31) and Keeton (11) support this view. One must grant that if the reversed movements do not cause nausea, they are prac-

tically always associated with nausea and vomiting elicited by duodenal stimulation.

It is evident from this brief review of the physiology of the duodenum that that organ, although not a vital one, is a very important one, and that it dysfunction may lead to serious results.

BIBLIOGRAPHY

1. WHEELON: Jour. Am. Med. Assn., 1923, LXXX, 615.
2. COLE: Am. Jour. Physiol., 1917, XLII, 618.
3. LUCKHARDT, PHILLIPS and CARLSON: Am. Jour. Physiol., 1919, L, 57.
4. WHEELON and THOMAS: Am. Jour. Physiol., 1922, LIX, 72.
5. IVY: Am. Jour. Physiol., 1918, XLVI, 340, 420.
6. IVY and VLOEDMAN: Am. Jour. Physiol., 1925, LXXII, 99.
7. CUNHA: RADIOLOGY, 1925, V, 459.
8. ALVAREZ: Am. Jour. Med. Sci., 1919, CLVIII, 609.
9. DRAGSTEDT and DRAGSTEDT: Jour. Am. Med. Assn., 1922, LXXIX, 612.
10. IVY and McILVAIN: Am. Jour. Physiol., 1923, LXVII, 124.
11. KEETON: Arch. Int. Med., 1925, XXXV, 687.
12. HENDERSON: Jour. Am. Med. Assn., 1925, LXXXV, 1462.
13. FRIEDMAN, SIRAUS and ARENS: RADIOLOGY, 1925, V, 93.
14. THORING and SMITH: Trans. South. Surg. Assn., 1917, XXX, 176.
15. BRUNEMEIER and CARLSON: Am. Jour. Physiol., 1915, XXXVI, 191.
16. BRICKNER and MILCH: Internat. Clin., 1926, 2, 241.
17. BURGET: Am. Jour. Physiol., 1925, LXXIV, 583.
18. GRAHAM: Proc. Inst. Med., Chicago, 1926, VI, 88.
19. KOSKOWSKI and IVY: Am. Jour. Physiol., 1926, LXXV, 640.
20. IVY, LIM and MCCARTHY: Quart. Jour. Exper. Physiol., 1925, XV, 55.
21. IVY: Ann. Clin. Med., 1926, IV, 798.
22. MOORHEAD and LANDES: Jour. Am. Med. Assn., 1919, LXXII, 1127.
23. DRAGSTEDT, DRAGSTEDT, McCLINTOCK and CHASE: Am. Jour. Physiol., 1918, XLVI, 584.
24. MANN and KAWAMURA: Jour. Am. Med. Assn., 1919, LXXIII, 878.
25. MILLER: Proc. Soc. Exper. Biol. and Med., 1926, XXIII, 835.
26. IVY: Northwest Med., 1926, XXV, 399.
27. DOWNS and EDDY: Am. Jour. Physiol., 1921, LVIII, 296.
28. KING: Am. Jour. Physiol., 1926, LXXVI, 201.
29. ARNOLD: Am. Jour. Dis. Child., 1926, XXXI, 668.
Jour. Inf. Dis., 1926, XXXVIII, 249.
Am. Jour. Hyg., 1926, VI, 672.
30. ALVAREZ: Jour. Am. Med. Assn., 1917, LXIX, 2018.
31. WHEELON: Jour. Am. Med. Assn., 1926, LXXXVI, 326.

- 32 ORNDOFF: Personal communication.
 33 CASE: Personal communication.
 34 CARLSON: *The Control of Hunger in Health and Disease*, Chicago, 1916.

DISCUSSION

DR. A. A. GOLDSMITH (Chicago): After hearing this series of papers of such great importance, very little is left to be said by a mere internist. I would like to mention a few points that strike me from the medical standpoint. First of all, I believe that in the fields of the colon and duodenum we have the most difficult fields of medicine, because the clinical pictures are not at all clear-cut and some of them overlap. I was interested to note that in a paper by Ratkoczi, a Hungarian, he reports a series of 4,500 examinations made during a period of two years. Something like six-tenths of 1 per cent of these showed obstructions in the duodenum. That means one out of each two hundred persons examined. That is much more than the average man discovers, and it leaves a question possibly as to why more have not been found. The one interesting point is that it allows us some leeway in making our diagnosis. I think many of us are forced at times to some conclusion, where we have no right to draw one. We are inclined to think that in the stomach we have three diseases, gastric ulcer, cancer, and syphilis, and if the case is not one of those three, we are "up a stump." There are a few other things we can lay our fingers on now and then, that may allow a few more diagnoses. We all have hobbies in our medical work, and that applies not only to internists and surgeons but to X-ray men also. It is a very common thing for roentgenologists to report chronic appendicitis. Many of those patients do not respond to an appendix removal. It may be that they have trouble about the cecum, or the trouble may be elsewhere, perhaps in the duodenum. Men who are working in certain lines will find all their cases conform to that particular disease. We had in Chicago formerly a well-known internist who was prone to diagnose everything as peptic ulcer, and in one hospital it became a joke among the internes; they would classify

the ulcers as of two kinds, ordinary peptic ulcer and "Dr. Brown's ulcer." That just means that persons working in one line are apt to have a hobby. My hobby is that I am apt to look for colitis, yet many of my patients may not have that at all. Then we must refer to the spasm of the pyloric tract. We often have opinions of an ulcer handed out to us, and yet we know that at operation no ulcer is found, and so these things have to be checked up and worked over carefully. Now, in regard to constipation: we know that many of our patients come to us and say they have a movement once in seven days or once in ten days or once in two weeks and are perfectly happy and comfortable, and yet another man may go only two days and have marked discomfort. It may be that the cecum is pulled down and causes a slight obstruction in his case and he does really suffer, yet we are prone to say that he is neurotic and should not bother about it. I know that years ago when the X-ray men first began to use the fluoroscope, every case was said to be a viscerotonic; every patient had the colon and the small intestine low down. Finally they came to realize that was the normal position for the stomach and intestines when the individual was standing erect. The idea they had in the past of the normal position of the colon came from the fact that they had seen it only at autopsy, when the body was lying on the table.

I think Dr. Wolfer is right on one point, and that is alkalosis. It is common to treat all ulcers by means of alkalis. In a doubtful case, a person may have no ulcer, and if you fill him up on the alkali, you may still favor the alkalosis and have serious trouble.

Then we wish to emphasize in particular the fact pointed out by Dr. Ivy, and other speakers, that all parts of the gastro-intestinal tract are subject to reflex action, and, therefore, trouble in a distant part may bring about spasm up here in the duodenum.

DR. I. SETH HIRSCH (New York): The papers this afternoon have been so rich in material and so full of suggestions that it is

practically impossible to attempt to discuss them all, though they all merit commendation and discussion. I shall confine my remarks to a condition which is not as yet a completely understood or generally appreciated entity—stenosis at the duodeno-jejunal junction. The stenosis may be intermittent or persistent. The examination must be a fluoroscopic one, with an inert mixture of barium and water. The mixture passes readily through the pylorus into the bulb and through the duodenum to the jejunal flexure but not beyond it. The duodenum soon becomes distended, while antiperistaltic waves drive the contents back into the bulb and even through the pyloric opening. These pendulum movements continue in the dilated duodenum for ten to fifteen minutes and give the impression of a complete organic obstruction at the duodeno-jejunal flexure. Then suddenly the contents are ejected into the jejunum and the obstruction seems to be relieved. This may or may not be repeated many times. The cause of this intermittent obstruction is in some cases mechanical, due to extrinsic pressure of various kinds, and in others the cause is spasm, either complicating the pressure or existing by itself. Under the mechanical causes may be mentioned the compression of the duodenum produced by visceroptosis and elongation of the mesentery. The effect of this ptosis is increased in asthenics and emaciated individuals. That this cause is sufficient to produce this pressure can be determined by examining the patient in the lateral postures or in the knee-chest position or by manually raising the stomach, thus removing the drag. This relieves the obstruction, and allows free duodenal motility.

A movable extra-gastric tumor or an old ulcer on the lesser curvature of the stomach in the pars media may also produce intermittent obstruction. The obstruction, however, occurs not only because of the forces producing the pressure but because of the accompanying and associated spasm at the duodeno-jejunal junction. Simple spasm producing intermittent stenosis may be associated with ulcer of the bulb, with appendicitis, constipation, colitis, etc.

The intermittent obstruction in the duodenum causes a delay in the evacuation of the stomach, in spite of the gastric hyperperistalsis which is always present. The stomach in its morphology then resembles in some respects the condition due to ulcer pyloric stenosis, the difference being that the loss of tone is never so marked and the peristalsis is more vigorous. In persistent stenosis only a small quantity of the contrast material passes through the duodeno-jejunal junction. The duodenum is, however, more or less completely filled, because the evacuation is never sufficient. The antiperistalsis and pendulum movements are vigorous. The duodenum may become enormously dilated. The evacuation of the stomach is delayed and a medium sized residue may be found at the six-hour examination.

The commonest causes of persistent duodeno-jejunal stenosis are infiltrating growths of the stomach or pancreas, post-operative adhesions, and rare cases of duodenal tumor.

The simple spastic and static form of intermittent obstruction is not so generally appreciated as it should be. It is not sufficient for the establishment of the diagnosis of intermittent duodenal stenosis, that the phenomena I have described, the delay in the duodenum and active pendulum movements be observed only once and not observed again during the examination. Such a series of events may be seen once under what we must still consider normal conditions. But to constitute a real entity and be of sufficient importance to explain the symptoms it must be frequently repeated during the course of the examination and the final result must show a small gastric and duodenal residue at the six-hour examination.

It is difficult to convince clinicians that this condition actually occurs, because, as the end-result, there may be only this minimal residue in the duodenum. The cause of the patient's symptoms is sought in the cecal region or elsewhere. There are, however, surgeons and clinicians, like Dr. Kellogg, who understand this condition and have operated for its relief. It should be borne in mind that even in the presence of an organic lesion, such as a

tumor or adhesions, it is not so much the adhesion or tumor which produces the stenosis as the spasm accompanying the lesion. . So that frequently, even in adhesions, the patient's condition may be markedly improved by the administration of antispasmodic.

DR. LEWIS GREGORY COLE (New York): What Dr. Case said regarding the frequency and significance and the infrequency and the lack of significance of this condition of duodenal stasis and duodenal obstruction absolutely corresponds with my conception of the thing, much as I regret to state it. [Laughter.] Perhaps I missed, before I came in, a consideration of one of the factors of duodenal obstruction, and I will ask if any essayist took up the question of duodenal obstruction resulting from pressure of the mesentery on the anterior surface of the duodenum. Only one thing I do wish to defend—and here I have Dr. Case against me—and that is the method in which the peristaltic wave progresses through the duodenum and probably through the small intestines. It starts about a quarter of an inch beyond the pyloric valve and progresses through the duodenum, at least, and probably through the small intestines. I think perhaps we will admit the possibility that it goes through the rest of the small intestines, because we are only now discussing the duodenum. The fact that the food comes out of the stomach and goes directly through the duodenum is a thing to which we must take exception. The duodenum, in my opinion, is replenished from the cap, and the cap is filled, as I have said, by peristaltic contraction, forcing some of the chyme through the pyloric valve into the cap. Sometimes it is more and sometimes less. If the peristaltic wave is active, I believe it is more; if it is feeble, I believe it is less. I believe it comes through the sphincter into the cap. I am using the wrong term; I mean through the *valve* into the cap, during systole.

DR. ARTHUR R. BLOOM (Chicago): I have just had the opportunity of going over some two hundred records of cases in which duo-

denal stasis has been found, and in those cases I find that about 65 per cent of the patients in whom duodenal stasis was present, had a pathological gall bladder, about 25 per cent of the cases had ulcer or chronic appendix, and in only about 5 per cent were we unable to determine any cause.

In the cases of obstruction, Dr. Wolfer mentioned distant hernia. I am reminded of a case we examined about a week ago in the Michael Reese Hospital, in which after five hours we found that most of the barium was still in the stomach and duodenum. The small intestines were outlined about a foot beyond the pylorus. At operation a femoral hernia was found.

DR. WOLFER (closing): I should like to ask two questions: First, I should like to ask Dr. Ivy if he will give us his theory as to why the blood chlorides are decreased in these cases of obstruction with pernicious vomiting. The other question is in regard to the remarks made about spasm. Have any of you used magnesium sulphate? This was first called to my attention in overcoming spasm at the recto-sigmoidal junction in doing sigmoidoscopic examinations. When an application of 50 per cent solution of magnesium sulphate solution is made to the area of spasm it will relax at once. I followed this up with its use in esophageal spasm in cases of carcinoma of the esophagus. The patient was given a small quantity of barium suspension and then several ounces of 33 per cent magnesium sulphate solution. It was like pulling out the stopper. We have tried magnesium sulphate in gastric and duodenal spasm but without any definite results. I wish you would try it and let us know what happens.

DR. IVY (closing): I will attempt to answer Dr. Wolfer's question as to alkalosis and reduction of chlorides. It has been well demonstrated in the rabbit, an animal which does not vomit, that alkalosis and reduction of blood chloride is not due to the loss of gastric secretion by vomiting. I personally,

have seen tetany, associated with alkalosis and reduction of chlorides, in six or seven different conditions. I have seen it following pyloric and intestinal obstruction; I have seen it in duodenal fistula animals; I have seen it in pancreatic fistula animals that were secreting a great deal of juice; I have seen it in animals following removal of the celiac ganglion; I have seen it in dogs sick from the effect of roentgen rays, and it is well known to occur in some persons on forced breathing. My own personal opinion of the reduction of

chlorides that we observe in these conditions is that it is only a concomitant phenomenon, not a fundamental one. Mathews points out in his text book of Physiological Chemistry, that the reduction of blood chlorides may be due to the action of some toxic or unknown factor, that is causing the tissues to retain chlorides. Too much emphasis has been placed on the occurrence of alkalosis and reduced blood chlorides, and not enough on the more fundamental question as to the cause of the alkalosis and low chlorides.

THE FREQUENCY OF MULTIPLE ABDOMINAL LESIONS¹

By ROBERT A. ARENS, M.D., and ARTHUR R. BLOOM, M.D.,

Roentgenologist and Assistant Roentgenologist, Respectively, of Michael Reese Hospital,
CHICAGO

THE simultaneous or consecutive appearance of diseases in different organs always presents the possibility that these diseases may be related. However, when this occurs as frequently as is found in cases of duodenal ulcer, chronic appendicitis, chronic cholecystitis, colitis, etc., one can hardly presume this relationship to be a mere chance or coincidence. These are much more common than reported by our surgical confrères, when we take into account the number with which the pathologist and roentgenologist meet.

Mix (1) reported three cases of combined duodenal ulcer and cholecystitis, while Judd (2) reported four cases, MacLaren and Oerting (3) reported five, and Macdonald (4), one. Soper (5) described three cases of cholecystitis and proctosigmoiditis and one case of gall-bladder infection combined with gastro-enteritis. Moorhead (6), Moore (7) and numerous other writers have called attention to the frequent concurrence of cholecystitis and appendicitis, and duodenal ulcer and chronic appendicitis.

ETIOLOGY

The question of etiology as well as the anatomical and physiological relationship of the various abdominal organs has been so ably discussed by Lyon and Swalm (8) that we can do little better than to quote them freely.

"For many years, too great emphasis has been laid on the gall bladder as the chief offender. Until recently we have not clearly enough recognized the concurrent infection and degenerative changes in the liver, bile ducts, pancreas, and intestines which play a

prominent rôle in gall-tract diseases and produce a widely varying digestive complex.

"To understand the protean nature of gall-tract diseases, it is important not only to recognize the close anatomic contacts that exist between the stomach, duodenum, pancreas, liver, gall bladder, gall ducts, and certain portions of the colon, but also to realize the intimate interrelationship for producing or transplanting disease that exists between these organs because of their blood, lymph, and nerve supply. . . .

"A close study of the factors concerning the continued or relapsing ill health of the victim of chronic gall-tract disease will show that there are three vicious circles at work. The first is concerned with the lymphatic drainage between the gall bladder, liver, and pancreas. . . . In the second and third vicious circles . . . the liver or ducts, or more commonly both, continue to carry the infected and poisoned bile into the duodenum and down through the intestines to exit in the feces . . . and re-absorption of bacteria or toxic substance in the bile by way of the mesenteric veins emptying into the portal vein, thence back to and through the liver."

MacCarty (9) also called attention to the fact that "the gall bladder, liver, duodenum, pancreas, and stomach are embryologically, anatomically, physiologically, and pathologically closely related and that they should be considered as a gastro-duodeno-hepaticopancreatic physiological system."

Dieulafoy (10) contended that the gall bladder is the primary focus in these combinations, Kelling (10) placed the origin in liver infections, while Williams (11) believed that a duodenitis may be followed by a cholecystitis through contiguity. Brooks (12), LaRocque (9), and Laplace (13) placed the blame on the appendix. Zweig

¹Read before the Chicago Roentgen Society, Nov. 11, 1926.

(14) asserted that the result of such complications should be regarded as the consequence of an infection which originated in the intestines.

With so many conflicting views, one is at a loss as to where to place the starting point. But, after all, is it necessary that there be one and only one site from which this disease combination must originate? Is it not possible that an infection may localize at any one point along the circuit and pass from there onward? We believe it is. From the large number of cases of uncomplicated cholecystitis, appendicitis, or duodenal ulcer, it is logical to suppose that the lesion may start at any place in the physiological and anatomical circle and proceed to the other organs and involve them.

RADIOLOGICAL FINDINGS

In order to determine the frequency of the co-existence of abdominal lesions, we reviewed the records of a considerable number of cases. Our purpose was to present these factors as found by the X-ray, which discloses lesions whose symptoms and clinical picture are often overshadowed by a more prominent condition; also in those cases in which the symptomatology is confused by virtue of the multiplicity. The efficiency of these examinations has been discussed in previous communications (15 and 16).

The method of examinations in all our gastro-intestinal series is as follows: the patient is prepared by an appropriate catharsis the night before, is given an enema in the morning, and reports without breakfast at 9 A. M. Primary gall-bladder films are taken (15). The patient is then given a barium meal and the stomach and duodenum are examined for intrinsic defects and for secondary evidence of gall-bladder disease, such as a gall-bladder seat, stasis, regurgitation, fixation of cap, etc. Frequently, for various reasons, we are unable to continue

beyond this point, and this is what we call a partial gastro-intestinal examination. When the entire alimentary tract is to be investigated (complete gastro-intestinal examination), the patient is then examined at 24 and 48 hours and further, if necessary to determine the condition of the ileum, appendix, and colon. An opaque enema is given at an appropriate time. It will be noted that a partial gastro-intestinal examination includes nothing beyond the duodenum. Although we prefer to make a complete study of the gastro-intestinal tract in all cases, we are often limited by the internist and surgeon.

The records of 844 patients in whom complete gastro-intestinal roentgen-ray examinations have been made are here reviewed. This leaves out of consideration 852 cases in which only partial examinations have been made. The reason for this is that, although numerous cases of multiple lesions were found in this group also, the work was not carried far enough to include or exclude further involvement. We feel that complete examinations might have disclosed additional information which, under the circumstances, we were unable to obtain.

Out of the 844 cases, 159 were found free from any lesions. The remainder was divided into four groups. In the first group, of 171 cases (Table I), there were 59 cases of duodenal ulcer and 16 of probable duodenal ulcer. The remainder, or 56 per cent, of the cases in this class were combined with other lesions. In the second group, of 343 cases (Table II), 42.5 per cent of gall-bladder infections were unaccompanied by other lesions. In the third, which comprised 254 cases (Table III), 40.5 per cent were found to have a pure chronic or probable chronic appendicitis. In the fourth group, of 165 patients (Table IV), 51 per cent presented the findings of an uncomplicated colitis. (We failed to find a possible etiological factor.)

TABLE I

Total number of cases in which a positive or probable duodenal ulcer was found, 171.

	No.	Per cent
Duodenal ulcer	59	34.50
Probable duodenal ulcer	16	9.35
Duodenal ulcer and pathologic gall bladder	18	10.50
Duodenal ulcer and chronic appendicitis	22	12.86
Duodenal ulcer and probable pathologic gall bladder	11	6.43
Duodenal ulcer and colitis	10	5.84
Duodenal ulcer and chronic appendicitis and pathologic gall bladder	5	2.97
Duodenal ulcer and chronic appendicitis and colitis	3	1.75
Duodenal ulcer or probable duodenal ulcer, with miscellaneous other gastro-intestinal lesions	27	15.80
Total	171	100.00

TABLE II

Total number of cases in which a positive or probable pathologic gall bladder was found, 338.

	No.	Per cent
Pathologic gall bladder	83	24.55
Probable pathologic gall bladder	63	18.63
Pathologic gall bladder and chronic appendicitis	44	13.01
Probable pathologic gall bladder and chronic appendicitis	26	7.70
Pathologic gall bladder and colitis	26	7.70
Pathologic gall bladder and duodenal ulcer	18	5.32
Probable pathologic gall bladder and colitis	20	5.92
Pathologic gall bladder, appendicitis, and colitis	12	3.55
Probable pathologic gall bladder and duodenal ulcer	11	3.26
Pathologic gall bladder, or probable pathologic gall bladder, with miscellaneous gastro-intestinal lesions	35	10.36
Total	338	100.00

TABLE III

Total number of cases in which positive or probable pathologic appendix was found, 254.

	No.	Per cent
Pathologic appendix	87	34.26
Probable pathologic appendix	16	6.30
Chronic appendicitis and pathologic gall bladder	44	17.32
Chronic appendicitis and probable pathologic gall bladder	26	10.24
Chronic appendicitis and duodenal ulcer	22	8.66
Chronic appendicitis and colitis	17	6.69
Chronic appendicitis and pathologic gall bladder and colitis	12	4.72
Chronic appendicitis and pathologic gall bladder and duodenal ulcer	5	1.96
Chronic appendicitis or probable chronic appendicitis, with miscellaneous gastro-intestinal lesions	25	9.85
Total	254	100.00

TABLE IV

Total number of cases in which colitis was found, 165.

	No.	Per cent
Colitis	84	50.99
Colitis and pathologic gall bladder	26	15.75
Colitis and probable pathologic gall bladder	20	12.09
Colitis and chronic appendicitis	17	10.29
Colitis and duodenal ulcer	10	6.04
Colitis, with miscellaneous gastro-intestinal lesions	8	4.84
Total	165	100.00

TABLE V

Total number of cases examined, 844.
Total number of pathologic cases, 685.

	No.	Per cent
Duodenal ulcer only.....	59	8.61
Probable duodenal ulcer only.....	16	2.34
Pathologic gall bladder only.....	83	12.11
Probable pathologic gall bladder only.....	63	9.20
Pathologic appendix.....	87	12.70
Probable pathologic appendix.....	16	2.34
Colitis.....	84	12.26
Total.....	408	59.56
Combined lesions.....	277	40.44

These findings (Table V) show that in only about 59.5 per cent of our cases, in which pathological conditions occurred, was one demonstrable lesion alone present.

Other writers have described similar results. A. Blalock (17) showed that 25 per cent of his gall-bladder operations revealed definite pathological conditions in addition to those affecting the biliary tract. Johnson (18) showed that in 45 out of 100 cholecystectomies the appendix was involved. Soper (5) reported that 41.5 per cent of his 411 gall-bladder cases disclosed definite relationship to other infectious processes in the gastro-intestinal tract.

In view of these findings, we urge that complete gastro-intestinal roentgenologic examinations be made in all cases in which there is a history of abdominal disease, although in certain cases a partial examination may suffice, depending upon certain previously known factors. Even in those cases in which the history and clinical picture pointed definitely to one organ, we have frequently found other organs involved. In those cases in which the financial status of the patient is such that he cannot afford the additional expense, some arrangement should be made by the roentgenologist to carry the work through, as the interest and welfare of the patient demand that every facility be used to elicit the entire pathological picture. This and this only should satisfy the physician or surgeon.

CONCLUSIONS

1. Cases of combined abdominal lesions have been frequently reported.
2. There is a direct anatomico-physiologic relationship between the gall bladder, bile ducts, duodenum, intestines, appendix, and colon. This results in a vicious circle. The infection may start any place in the circuit and proceed onward.
3. Only 59.5 per cent of our series revealed uncomplicated lesions. The rest were associated with other involved viscera.
4. We urge that complete gastro-intestinal examinations be made in order that other involved organs may not be overlooked.

BIBLIOGRAPHY

- (1) MIX, C. L.: *Med. Clin. N. Am.*, September, 1923, VII, 337.
IDEM: *Med. Clin. N. Am.*, 1917, II, 785.
- (2) JUDD, E. S.: *Ann. Surg.*, April, 1922, LXXV, 459.
- (3) MACLAREN, A., and OERTING, H.: *Surg., Gynec. and Obst.*, January, 1924, XXXVIII, 92.
- (4) MACDONALD, H. G.: *Jour. Med. Soc. New Jersey*, October, 1920, XVII, 349.
- (5) SOPER, H. W.: *Ann. Clin. Med.*, November, 1923, IV, 422.
- (6) MOORHEAD, E. L.: *Surg. Clin.*, June, 1920, IV, 641.
- (7) MOORE, F. D.: *Surg., Gynec. and Obst.*, September, 1922, XXXV, 338.
- (8) LYON, B. B. V., and SWALM, W. A.: *Jour. Am. Med. Assn.*, Nov. 14, 1925, LXXXV, 1541.

- (9) MACCARTY, W. C., quoted by SCHILLING, N.: Jour. Iowa St. Med. Soc., May, 1916, VI, 211.
- (10) KELLING, G.: Arch. f. Verdauungskr., 1921-22, XXVIII-XXIX, 63.
- (11) WILLIAMS, W. H.: Jour. Ind. St. Med. Assn., July, 1916, IX, 283.
- (12) BROOKS, H.: Med. Clin. N. Am., July, 1924, VIII, 7.
- (13) LAPLACE, E.: Penn. Med. Jour., May, 1918, XXI, 518.
- (14) ZWEIG, W.: Arch. f. Verdauungskr., 1921, XXVII, 128.
- (15) FRIEDMAN, J. C., STRAUSS, A. A., and ARENS, R. A.: RADIOLOGY, August, 1925, V, 93.
- (16) ARENS, R. A., and BLOOM, A. R.: RADIOLOGY, December, 1925, V, 513.
- (17) BLALOCK, A.: Bull. Johns Hopkins Hosp., December, 1924, XXXV, 391.
- (18) JOHNSON, W. O.: Am. Jour. Med. Sci., August, 1925, CLXX, 181.

Relation between hypophysis and genital organs.—This first article in an intended series deals with the investigations of the relation between hypophysis and genital organs. Eight rabbits and five dogs were treated over the right and left temporal region, and the frontal; in the first group, three out of five rabbits (ten weeks old) received approximately 25, 35, and 45 per cent E.D. to the hypophysis. The two remaining animals served as controls. (Technic: 3.0 Al., 25 cm. F.S.D., quality of radiation 11 to 12 Wehnelt; this would correspond to a half value layer of 1.2 to 1.4 cm. water.) After 60 to 74 days, all five animals were killed. There was no appreciable change in the gained weight; no macroscopical changes could be noticed in any organ. Section of the hypophysis showed more eosinophiles than normal; the individual cells seemed larger. No stimulating effect of small doses of roentgen rays may be deduced from this result.

In the second group, two out of three rabbits (7 months old) were exposed to 130 per cent E.D. effective in the hypophysis (180 K.V., 4 ma., 0.5 Cu. plus 1.0 Al., 23 cm. F.S.D., 2×5 cm. field, over the temples and 4×6 cm. field over the frontal, one E. D. surface dose per field). After 72 days all

three rabbits were killed. One treated animal had lost in weight. Histological section of the hypophysis showed degeneration and atrophy. No changes in the genital organs were noticed.

The third group consisted of five dogs (8 weeks old) that received 75 to 130 per cent E.D. effective in the hypophysis, of the same radiation as used in Group 2. The heavily treated dogs were killed after 58 and 72 days, the other and the control died after 76 days. The cause of death was undetermined. As a result of the treatment, the growth and development appeared delayed. The genital organs were atrophied.

There seems to be a great difference between the reaction of adult and young growing animals following X-ray radiation to the hypophysis. The relation between genital organs and the pituitary gland requires further investigation.

E. A. POHLE, M.D.

Experimental Investigations Concerning the Relation between Hypophysis and Other Inner-secretory Glands. I.—On the Question of the Correlation between Hypophysis and Genital Organs. L. D. Podljaschuk. Strahlentherapie, 1927, XXIV, 439.

LIMIT EXPOSURE IN RADIOGRAPHY

By ERNST A. POHLE, M.D., Associate Professor of Roentgenology,
University of Michigan Medical School, ANN ARBOR, MICHIGAN

THE last few years have brought us important developments of measuring apparatus and measuring methods, the intelligent application of which enables the roentgenologist to reproduce a certain dose in X-ray therapy. Physical (*c*-unit, roentgen unit) and biological (erythema dose, skin unit dose) units have been introduced and are generally accepted, to express the amount of roentgen energy applied to the human skin. Very little use has been made of these factors in the diagnostic branch of roentgenology, although there is no doubt regarding the necessity of establishing some definite idea of the tolerance dose of roentgen energy as delivered by the diagnostic apparatus and tubes in operation to-day. The fact that there are cases reaching the courts every year claiming damage for an alleged overdose received in connection with a roentgen-ray examination warrants this investigation. It is well known that the majority of such patients have been subjected to a fluoroscopic examination, either for the removal of a foreign body or the examination of some fracture difficult of reduction. Sometimes cases of too frequently repeated gastro-intestinal examinations appear also in this group. A recent survey, in Germany, by Groedel, Lini-ger, and Lossen (1), of 82 roentgen-ray injuries which came to trial and of which 21 belonged to the diagnostic group, emphasizes again the importance of our problem. Following the suggestion of the Editor of this Journal, an outline of the present status of "dosimetry in diagnostic roentgenology" will be given.

The roentgenologist who is searching through the text-books for some advice will

not find very much information on this subject. All authors (2) agree that a filter of one millimeter thickness should be used, as a rule, in all diagnostic work. It is also essential to ask the patient if a diagnostic examination of the same part of the body has been done during the last three weeks, or an X-ray treatment given to the same area (3). Six rules are given by Lorey (4). Nobody should make an attempt to use a fluoroscope unless he has had adequate training in roentgenology. If the patient has been fluoroscoped within the last two or three weeks, no examination should be done. Every patient who has taken iodine, bromide, or salvarsan recently should be handled with great care; an aluminum filter of from one-half to one millimeter thickness has to be inserted between the tube and the patient; the tube holder and screen should be so arranged that a minimum focal skin distance is always assured, and this should be at least 60 centimeters (24 inches). The milliamperage must be controlled during the roentgenoscopic examination.

Witherbee and Remer (5) offer in their booklet a number of formulæ for the calculation of the dose in superficial therapy, including a very simple procedure which is said to enable the roentgenologist to figure out the tolerance of the skin in diagnostic work. The writer feels that no such general rule can be established, based on calculation only, because of the well-known variation in the output of the various machines and tubes.¹ For that reason, the values given later in this essay must be regarded merely as examples and as general guides,

¹See Meyer and Glasser (*l.c.*), also their letter in the *American Journal of Roentgenology and Radium Therapy*, Feb., 1927, XII, 277, and Pohle (this Journal, 1926, VI, 236, Footnote 2).

which are correct only for the apparatus on which they were measured.

Several years ago Erskine (6) undertook a series of actual tests on the skin to de-

studied the output of several diagnostic machines with a Wulff ionometer, calibrated in roentgen units. Comparing the roentgen energy delivered under the same conditions

TABLE I

Author	K.V.	Ma.	F.S.D. in cm.	Filter mm. Al.	Field in sq. cm.	Min. E.D. in min.	E.D. in min.	Roent. per sec.	Remarks	E.D. in R-units ³
Erskine	60	10	25	0	2 x 2	0.66	1.33	-----	-----	-----
	60	10	25	1.0	2 x 2	1.33	3.0	-----	-----	-----
Frik	70	5	35	0.5	-----	-----	45 ⁴	0.26 ⁵	Chest fluoroscope	700
	98	5	35	0.5	-----	-----	26	0.47 ⁵	Gastro-intestinal fluoroscope	700
	105	200	55	0.5	-----	-----	-----	5.9 ⁶	Chest films	-----
	63	200	55	0.5	-----	-----	-----	1.9 ⁶	Chest films	-----
	105	60	35	0.5	-----	-----	-----	3.0 ⁶	Gastro-intestinal films	-----
Meyer and Glasser	75	-----	-----	0	large	-----	-----	-----	-----	620 ⁵
	100	4	30	0	large	-----	3-8	-----	-----	520 ⁵
Pohle	75	5	30	0	} 15 x 15	-----	9.5	-----	Erythema time ratio approxi- mately 2:1 for	560 ⁶
	75	5	30	1.0		-----	20	-----	1.0 Al. filtered	450 ⁶
	100	5	30	0		-----	4	-----	and unfiltered	
	100	5	30	1.0		-----	9	-----	radiation	
Klein and Gaertner	100	2	30	0	-----	-----	8.5	-----	Mean value	384 ⁵
	100	2	30	1.0	-----	-----	20	-----	given: 380 R	398 ⁵

³German and American roentgen units are different. According to Glasser, the German R is 50 per cent higher than the American R. Frik, Klein, and Gaertner use the German value; the other figures in the last column refer to the American unit.

⁴Seven hundred R. measured on patient, are taken as E.D. for this radiation (German units).

⁵Chamber on water phantom or patient.

⁶Chamber in air.

termine the limit exposure in diagnostic work. His figures (see Table I) for the minimum and full E.D. appear somewhat low compared with our results. It must be remembered, though, that only 60 K.V. were used in his work. Recently Frik (7) presented the results of a series of measurements on diagnostic apparatus with the Siemens dosimeter. However, his erythema dose is undoubtedly too high (Table I), due to the fact that 700 R (German unit) are assumed as an erythema dose for the quality of radiation he employed; this would correspond to over 1,100 R as defined in this country. Based on the average of roentgen units required for an erythema dose when using 70 to 100 K.V., as given by Meyer and Glasser (8) and also on the skin tests done in our laboratory on six adults, we

by the diagnostic machines and the diagnostic Coolidge tube with the small therapy machine and a standard air-cooled 200 K.V. Coolidge tube, revealed less than plus or minus 5 per cent difference. Our skin tests were, therefore, done with the latter equipment. The results of these measurements are compiled in Table I. It appears that the observed and measured erythema doses are in reasonable agreement with the values given by Meyer and Glasser (*l.c.*) and Klein and Gaertner (9). For any other distance the equivalent time may be calculated; the same does not hold exactly true, however, in the case of different milliamperage (Pohle, 10).

The question arises, then, as to what percentage of the erythema dose is usually administered to the skin in diagnostic work.

Using the average figures given in Table I, it should not be difficult to arrive at an approximate idea concerning the ordinary roentgenogram. The only prolonged exposures take place in the fluoroscopic examination, be it chest, gastro-intestinal examination, localization of a foreign body, or manipulation under the screen. For a complete gastro-intestinal examination, in our department, including fluoroscopy and the maximum number of films taken, we find that an average of 3 per cent E.D. is given to the anterior surface and 60 per cent to the posterior surface of the body when using 75 to 100 K.V., 1.0 mm. Al. filter. Studies of the irradiated skin with the capillary microscope (Pohle, 11) did not reveal any of the typical changes due to the application of an erythema dose of roentgen rays.

In this connection, the possibility of an idiosyncrasy to roentgen rays should be considered. There seems to be an overwhelming opinion that no such high sensitivity to radiation can explain or excuse an injury. This may hold true for the majority of cases but not all; it must be stated that perhaps once in a long while a patient is discovered who shows an extreme susceptibility to roentgen rays. In our own experience, we observed a young Philippine physician whose teeth were examined by roentgen rays with the special dental apparatus and tube in general use; two days afterwards, the circular ports of entry on both cheeks showed a definite erythema, which disappeared after four or five days. He was free of any signs of Graves' disease or diabetes; no bromid, iodine, salvarsan, or mercury medication had been administered previously.

In conclusion, it is emphasized again that the figures given in Table I representing our own measurements should be regarded as relative values, because they are correct only for the apparatus and tube where the measurements were taken. We feel safe, however, in stating that no ill effect should result from applying half the energy given there as our erythema dose,² after due correction has been allowed for a different current through the tube and different distance. The same amount of roentgen energy may be used again after a month, in the average case. The experienced roentgenologist will have to use his judgment, which can not be replaced by any formula. There is only one absolute rule: No diagnostic exposure whatsoever should be done without inserting a one millimeter aluminum filter between tube and patient.

²According to a communication from O. Glasser, Ph.D., the mean value is approximately 550 R.

BIBLIOGRAPHY

- (1) Fortschritte auf dem Gebiete der Röntgenstrahlen, Ergänzungsband 36, Heft 1, 1925.
- (2) CHRISTIE, A. C.: Roentgen Diagnosis, Philadelphia, 1924, p. 52.
- (3) GRASHEY, R.: Atlas typischer Röntgenbilder, p. 26, Munich, 1923.
- (4) Irrtuemer der Röntgendiagnostik, pp. 132-3, Leipzig, 1924.
- (5) X-ray Dosage in Treatment and Radiography, New York, 1923.
- (6) Am. Jour. Roentgenol. and Rad. Ther., 1922, IX, 148.
- (7) Fortschritte auf dem Gebiete der Röntgenstrahlen, 1926, XXXIV, 180.
- (8) RADIOLOGY, 1926, VI, 320; Strahlentherapie, 1926, XXIII, 361; Strahlentherapie, 1927, XXIV, 710.
- (9) Fortschritte auf dem Gebiete der Röntgenstrahlen, 1926, V, 492.
- (10) RADIOLOGY, 1924, III, 504.
- (11) RADIOLOGY, 1926, VI, 236.

EXPERIMENTAL STUDIES IN CHOLECYSTOGRAPHY¹

By JULIUS FRIEDENWALD, M.D., MAURICE FELDMAN, M.D., and
FRANCIS X. KEARNEY, M.D., BALTIMORE, MARYLAND

THE advent of cholecystography has unquestionably established one of the most valuable contributions to the sum of our diagnostic methods in the study of gall-bladder disease. This method of examination has assumed such importance that it has already stimulated many workers to further investigations into the numerous problems related to gall-bladder pathology. It was soon recognized that the intravenous method of administration of the dye tetraiodophenolphthalein, as described by Graham and Cole, was not entirely satisfactory as a routine procedure. Due to the toxicity of the drug and the rigid technic required, many clinicians have discarded this method, preferring instead the oral route. Yet even this latter method has not been found entirely satisfactory, for, up to the present time, it has not been thoroughly standardized, due to the fact that the effect of the HCl of the gastric secretion on the dye and consequently on the amount that is absorbed in order to bring about visualization of the gall bladder has not been fully established. It is well known that even in normal individuals with the same dosage of the dye, shadows of the gall bladder may vary in density in various examinations on the same individual. Again, the various enteric coatings utilized to protect the drug from the action of the gastric juice do not entirely prevent the transformation of the dye into its insoluble salt. On this account, it seemed important to us to investigate experimentally the oral administration of the dye in animals in order to more fully determine the cause of certain of these difficulties.

The following problems presented themselves as worthy of investigation:

1. The visualization of the gall bladder by the oral administration of the dye in dogs and rabbits.
2. The determination of the effect of the hydrochloric acid of the gastric juice upon the dye in its relation to the visualization of the gall bladder.
3. The result, in this respect, of eliminating the stomach by
 - (a) administering the dye directly into the duodenum or other portions of the small intestine;
 - (b) excluding the gastric secretion by tying off the duodenum and administering the dye directly into the intestine.
4. The effect of food on the absorption of the dye in relation to the visualization of the gall bladder.
5. The effect produced by alkalies on the absorption of the dye.

These experiments were performed almost entirely upon large healthy dogs: in a few instances rabbits were utilized. Before any experiment was undertaken feeding of the animals was carefully regulated, food being allowed only according to the indications presented by the special investigation.

1. An attempt to visualize the gall bladder by the oral administration of tetraiodophenolphthalein.

(a) *Results obtained in rabbits.*—In four rabbits the dye in a dosage of 15 grains was administered through a catheter. The visualization of the gall bladder varied. In one instance we were able to secure a satisfactory shadow; in three, no definite

¹From the Gastro-enterological Clinic of the Department of Medicine and the Pharmacological Laboratory of the University of Maryland, Baltimore.

shadows were obtained. The results were, therefore, inconstant and unsatisfactory.

(b) *Results obtained in dogs.*—Sixteen experiments were performed for this purpose on dogs. The results noted by administering the dye by mouth in a dosage of 40 to 75 grains was unsatisfactory. In seven experiments the dogs were fed and in nine they were starved previous to the administration of the dye. In not a single instance could the gall bladder be visualized.

2. The determination of the effect of the hydrochloric acid of the gastric juice upon the dye in its relation to the visualization of the gall bladder.

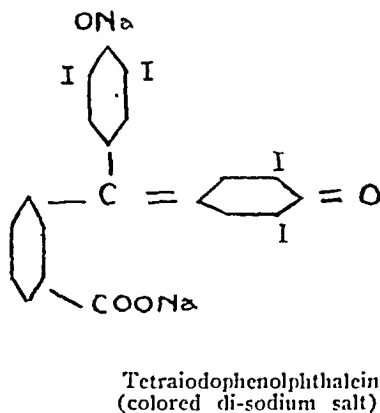
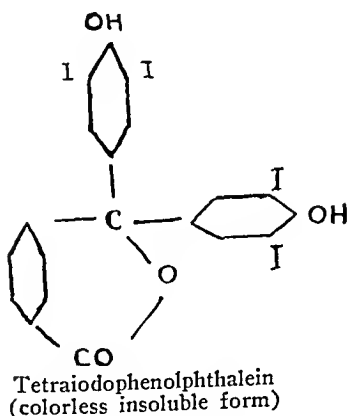
(a) In this investigation 50 to 75 grains of tetraiodophenolphthalein in capsules or dissolved in water were given through a tube. X-rays of the dogs followed at intervals of 10 minutes, 2½ hours, 3½ hours, 5 hours and again at 7, 7½, 11, 13, 15, 16½, 17, 19, 21½, 24, and 38 hours after the administration of the dye. In not a single instance could a gall-bladder shadow be obtained.

(b) In a further experiment 12 five-grain triple-coated salol capsules (kerasol capsules triple-coated with salol) were introduced into the stomach of a dog. There were no evidences of a gall-bladder shadow

when the animal was examined at 12½, 16, and 19½ hours.

It has been suggested that the inability to visualize the gall bladder in dogs is due to the extreme acidity of the gastric secretion in these animals. According to Stewart (*Manual of Physiology*, eighth edition, page 350) the hydrochloric acid in these animals ranges from 0.46 to 0.58 per cent. In addition, the unusual amount of mucus in the stomach of dogs may possibly also play some part in preventing visualization. The sodium salt of tetraiodophenolphthalein is soluble and is transformed into an insoluble salt by the action of the hydrochloric acid of the stomach, according to the formula below.

(c) *The results obtained following the use of dyes not ordinarily affected by acids.*—Failing to obtain a gall-bladder shadow by the methods described above, an attempt was made to determine the effect of dyes not acted upon or changed by the action of acids. For this purpose we utilized three dyes advised by Dr. E. C. White, which are opaque and probably excreted by the liver. Three dogs were used for these experiments. The dyes administered were diiodotetrachlorfluorescein, acetate of B-tetraiodofluorescein, and B-tetrabromfluorescein, given orally in doses of five grams. In



not a single instance was a gall-bladder shadow obtained.

(d) *Some observations on human beings regarding the effect of the acidity of the gastric contents in its relation to gall-bladder visualization.*—In 30 individuals in whom the total acidity of the gastric secretion ranged between 30 and 99 and the free HCl between 10 and 69, a gall-bladder shadow was obtained in 19 and was absent in 11. High acidities were noted in both filled and non-filled gall bladders. In three cases the free HCl was 50 and above; of these, the gall bladder was visualized in two instances and was not in one. Two of these patients were operated upon; in the one case that failed to fill in which the free HCl was 50, total acidity 66, a contracted gall bladder with stone in the common duct was found. In another case which filled, presenting a total acidity of 70 and free HCl of 50, gallstones were found at operation. In a case of duodenal ulcer with a total acidity of 99 and free HCl 69, a gall-bladder shadow was observed. In this case magnesium oxide and sodium carbonate were given for six days previous to cholecystography. From these observations as well as from many others in patients presenting high gastric acidities, we are convinced that in these individuals the gall-bladder shadow does not present the degree of density that one observes in individuals with normal acidities.

On the other hand, in observations in several hundred cases in which cholecystography was performed in human subjects by the oral method, in no instance were we able to determine that failure to visualize the gall bladder was due in any way to high gastric acidity. This is due to a large degree, however, to the fact that in order to obtain satisfactory shadows a rather large dose of the dye is required in order to be assured that sufficient of the unchanged substance passes into the intestine.

The following table presents a series of

30 cases in which cholecystography was performed, 10 of which came to operation. The acidities and operative findings are noted. The results indicate that the degree of acidity has but a slight influence upon the result of gall-bladder visualization in the human subject.

	Free HCl	Total Acidity	Gall-bladder Shadow	Operation
1	30	45	+	
2	20	32	+	
3	50	70	+	Gallstones
4	10	30	+	
5	20	39	—	
6	32	58	+	
7	27	52	+	
8	20	30	+	Cholecystitis
9	20	40	+	Cholecystitis
10	22	30	+	
11	23	48	—	Gallstones
12	25	57	+	
13	30	50	—	
14	30	57	—	
15	36	50	—	
16	34	45	—	
17	22	46	+	Gallstones
18	50	70	+	
19	20	35	—	
20	50	66	—	Stone Common Duct Contracted Gall Bladder
21	26	44	—	Gallstones
22	25	35	+	Gallstones
23	30	46	+	Gallstones
24	29	39	+	
25	40	55	—	
26	31	51	+	
27	20	35	—	
28	17	47	+	Cholecystitis
29	50	69	+	
30	69	90	+	

Note: + indicates positive shadows; — absence of shadow.

3. The result of eliminating the stomach by (a) *administering the dye directly into the duodenum or other parts of the small intestine, either by direct injection or through a fistula in dogs.*

Twenty-eight experiments were performed by introducing the dye in liquid or capsule form in dosages of 50 to 75 grams into various portions of the small intestine, that is, into the duodenum, jejunum, ileum, and cecum, respectively. In eight instances the dye was placed directly into the duodenum. A gall-bladder shadow was not visualized, except in two instances when a

faint shadow was observed upon the addition of 75 grains of bile salts added to an equal amount of tetraiodophenolphthalein.

In 15 experiments the dye was introduced into the jejunum; of these, shadows were visualized in six instances, while in four it was introduced into the cecum with negative results. In one instance, when introduced into the ileum, a shadow was obtained.

These experiments demonstrate that whenever the stomach is eliminated and the dye is administered directly into the duodenum or other parts of the small intestine, the gall bladder can only occasionally be visualized.

(b) Excluding the gastric secretion by tying off the duodenum and administering the dye directly into the intestine.

Inasmuch as we were unable to obtain visualization of the gall bladder constantly, due to the high acidity of the gastric secretion, which produced an acidity of the small intestine, we excluded the gastric secretion entirely by tying off the duodenum: nine experiments were conducted with this procedure. In seven, following the exclusion of the stomach, the dye was introduced into the duodenum, and in two instances into the cecum. In all nine we obtained constant shadows of the gall bladder, indicating that the failure of visualization in our previous experiments was entirely due to the high acidity of the gastric contents.

4. *The effect of food upon the absorption of the dye and visualization of the gall bladder.*—In fourteen experiments the dogs were fed (either by mouth or by means of injections through various parts of the intestinal tract) a combination of the dye together with peptone, erepton or beef extract. In not a single instance was a gall-bladder shadow obtained.

5. *The effect of alkalies on the absorption of the dye.*—Realizing that the failure of visualization of the gall bladder is due to a transformation of the dye, produced by the acidity of the gastric secretion, an attempt was made to neutralize the acid by means of sodium bicarbonate and sodium carbonate.

In five instances, the soda was given either orally with the dye or directly with the dye into the small intestine in liquid or capsule form, with negative results. One dog was given 10 five-grain capsules of the dye placed directly in the stomach through a tube forced through by means of a stylet. In addition, a three-ounce solution of sodium bicarbonate was introduced. X-rays of this animal were taken at intervals of 10, 12 and 14 hours, but in no instance was a gall-bladder shadow revealed. In another dog, 12 five-grain capsules were given with 3 ounces of a solution of bicarbonate of soda and introduced in an identical manner. On X-ray examination many of the capsules showed a beginning disintegration in 10 minutes. In $3\frac{1}{2}$ hours all of the capsules had disappeared from the stomach. In 5 to 7 hours the dye was noted in the intestine. The gall bladder could not be visualized under these conditions. Due to the fact that sodium bicarbonate contains an acid radical, sodium carbonate was used on another dog with exactly similar results.

In the above described experiments an enteric-coated capsule known as kerasol was employed.

SUMMARY

As a result of the foregoing experiments on animals the conclusion was reached that the visualization of the gall bladder by the oral administration of the tetraiodophenolphthalein is unsatisfactory in that in no instance could a gall-bladder shadow be obtained. This is entirely due to the high acidity which alters the form of the dye

into an insoluble salt. Even when eliminating the stomach by introducing the dye directly into the small intestine, a gall-bladder shadow is not constantly obtained until the gastric secretion is entirely eliminated by tying off the duodenum. Only under these conditions were we able to obtain constant findings. The visualization of the gall bladder is not in any manner influenced by food or alkalies.

CONCLUSIONS

From our experiments it is evident that the acidity of the gastric secretion plays an important rôle in cholecystography when practised according to the oral method.

On this account, in individuals affected with high gastric acidity, the lessened density of the gall-bladder shadows should not necessarily indicate an abnormal finding. It

appears to us that whenever the gall-bladder shadow is unsatisfactory, an investigation into the acidity of the gastric contents should be made.

Finally, inasmuch as the density of the gall-bladder shadow depends to a large degree upon the amount of the dye absorbed, large doses should be administered in order to be assured that a sufficient amount of dye passes into the small intestine in an unaltered form.

It is to be hoped that in the near future some new dye may be introduced for purposes of cholecystography which will not be influenced by the acid gastric secretion.

Note: We wish to thank Dr. H. A. B. Dunning, of Hynson, Westcott and Dunning, for his kindness in furnishing us with some of the material utilized in these experiments.

CASE REPORTS AND NEW DEVICES

CARDIOSPASM, WITH KINKING OF THE ESOPHAGUS FROM KYPHOSIS

By ALEXANDER B. MOORE, M.D., Section on Roentgenology, and PORTER P. VINSON, M.D., Division of Medicine, Mayo Clinic, ROCHESTER, MINNESOTA

Cardiospasm with diffuse dilatation of the esophagus is often seen with angulation in the lower third of the organ, but it is rarely seen with angulation in the upper portion.



Fig. 1. Cardiospasm, with marked dilatation of the esophagus and angulation of the upper third. Kyphosis of the dorsal spine.

In a recent report by Schall it has been shown that marked angulation of a normal esophagus may be associated with kyphosis. In the case reported here the esophagus is dilated as the result of spasmodic obstruction at the cardia, and the angulation in the upper portion is probably from spinal curvature. Another point of interest is the temporary retention of barium in the upper esophageal pouch noted in the roentgeno-

gram, anteroposterior view. Examination of such a film without fluoroscopic observation might readily result in an erroneous diagnosis of malignant stricture of the upper esophagus.

REPORT OF CASE

A man, aged sixty-five, was examined at the Mayo Clinic November 29, 1924. For



Fig. 2. Anteroposterior view showing retention of barium above the angulation.

six years he had experienced a sense of obstruction in the median-esophageal region to the passage of any type of food, and he frequently regurgitated food and mucus after meals and at night. Food was regurgitated that had been eaten two or three days previously. In the course of five years he had gradually lost 75 pounds, but during the last year he had regained 10 pounds. He coughed occasionally, following which he

regurgitated food. Pain had not been experienced.

General physical examination was negative, save for considerable kyphosis. Roentgen-ray examination revealed wide dilatation of the esophagus, and obstruction of the barium meal at the cardia. The cardia was stretched with the hydrostatic dilator and complete relief from dysphagia resulted.

The patient returned for examination October 27, 1926. The dysphagia had recurred recently, although it was not so marked as at the previous visit. Roentgenograms at this time showed obstruction of the barium meal at the cardia, with diffuse dilatation of the esophagus, and angulation in the upper third of the organ, with considerable sacculation above the angle (Figs. 1 and 2). Esophagoscopic examination was made without difficulty and, although the entire esophagus was widely dilated and filled with food particles and mucus, a definite angulation was not observed. Following another divulsion of the cardia with the hydrostatic dilator, the patient was able to eat any type of food without the slightest difficulty.

REFERENCES

1. SCHALL, L. A.: The esophagus in Pott's disease and scoliosis. *Ann. Otol. Rhinol., and Laryngol.*, 1927, XXXVI, 57-71.
2. VINSON, P. P.: A case of cardiospasm, with dilatation and angulation of the esophagus. *Med. Clin. N. Amer.*, 1919, III, 623-627.
3. VINSON, P. P.: Marked dilatation of the esophagus in cardiospasm. *Ohio State Med. Jour.*, 1924, XX, 147-148.

A CASE OF PNEUMOCEPHALUS

By N. J. NESSA, M.D., Sioux Falls Clinic,
SIOUX FALLS, SOUTH DAKOTA

The patient, D. P. M., aged 49, male, married, native American, by occupation a round-house hostler, was referred for X-ray examination by Dr. R. W. Mullen, of Sioux Falls, South Dakota, who supplied the history. The family and personal history was



Fig. 1. First roentgenograph taken Sept. 22, 1926. Posterior-anterior view. Note the large pneumocephalus on the left side.

essentially negative. The patient had not been operated upon. On the afternoon of September 16, 1926, six days before the date of the roentgenologic examination, he was found standing in his engine cab with blood on his face. He was irrational, and on being removed from the engine had a convulsion which lasted two minutes. He was known to have been working in the fire-box and the probability is that he became overheated and fell, striking his head. He was removed to the hospital where he had another convulsion lasting two minutes.

Physical examination showed a well developed and fairly well nourished man, restless and talking irrationally. The skin was of good color. There was a scalp wound, irregular in shape, 4 cm. in length, directly above the left eye. The examination was otherwise negative. The eye reflexes were normal. No paralysis or twitching of



Fig. 2. Lateral view, taken Sept. 22, 1926, with left side of head toward film.

muscles. Pulse 90, temperature 98. Blood and urine negative.

Patient remained irrational until September 19, when he regained consciousness; since that time he has continued to be rational. The convalescence was uneventful; the wound healed by first intention; temperature, pulse, blood and urine were normal, and the patient returned to work on October 15, feeling well.

Roentgenologic examination was made on September 22, at which time a large pneumocephalus was noted on the left side, frontal area, apparently connecting with the frontal sinus. Re-examination was made two days later, when this air content was greater. Another examination was made at a subsequent time, when the air content was becoming less. Final roentgenograph was made November 9, showing complete absorption of the pneumocephalus. Roentgen-

ologically, no definite evidence of fracture into the frontal sinus could be noted.

X-ray diagnosis was pneumocephalus, left, presumably connecting with the frontal sinus through fracture.

REFERENCE

DANDY, W. E.: *Archiv. Surg.*, August, 1926 (28 cases reported in the literature).

A SIMPLE METHOD OF CARDIOMETRY

By I. S. TROSTLER, M.D., CHICAGO

So much interest was displayed in my demonstration of this method at the annual meeting of the Radiological Society at Milwaukee, that it seems desirable that it be given to the readers of *RADIOLOGY*.



Fig' 1. Device for measuring the cardiac shadow (slightly over half natural size).

The great value and importance of keeping accurately informed regarding changes in the size of the heart, from time to time, is recognized by clinicians when they are treating or studying cardiac disease, and when this may be accomplished by so simple a method, it seems certain that all clinicians will welcome it.

With the technic about to be described, the circumference of the cardiac shadow may be measured as easily as reading the time on a watch, and almost as quickly. Its utility and adaptability should lead to its application in practically every heart case, either bedridden or ambulatory.

A roentgenogram is made of the thorax of the patient (preferably at 6 feet or 2 meters film target distance, but any distance will do). The outline of the heart shadow on the film is now measured by running the small wheel at the foot of the instrument around the shadow, and the circumference is read off in inches or centimeters as preferred (see accompanying photograph, Figure 1, which is slightly over half natural size).

At such later interval as is desired, another roentgenogram is made, under the same conditions as before (same film target distance). The shadow is again measured and it will be seen beyond any question, whether or not the heart has changed in size, and how much.

The process is as simple as is the telling; no lines to draw on the film, no calipers needed, and no computation or corrections made.

While showing it at Milwaukee, I was informed that Dr. Lewis Gregory Cole had used a somewhat similar instrument, so that, while I am claiming no originality, I still feel that the attention of radiologists and clinicians should be called to it. The instrument is inexpensive.

EDITORIAL

M. J. HUBENY, M.D. Editor
BENJAMIN H. ORNDORFF, M.D. } Associate Editors
JOHN D. CAMP, M.D. }

*Contents of RADIOLOGY copyrighted by the
Radiological Society of North America.*

THE DIAGNOSIS OF CARDIO-VASCULAR DISEASE

Heart disease, because of its prevalence, its chronicity with coincident economic effects, and finally because of its high rank as a cause of death, has become a problem of the utmost importance.

This has resulted in the formation of a national association for the study of the cause and prevention of heart disease, with local associations organized for the same purpose in many of the large cities.

Cardiac clinics have been formed over the whole country, to care for the cardiac, and, incidentally, the collection of material to forward this study.

The diagnosis of cardiac disease in an individual involves grave responsibility, when it is realized that that individual's entire course in life depends upon the accuracy of the diagnosis and the proper evaluation of the handicap thereby imposed. Errors in diagnosis may determine a course in life that is all but ruinous.

A cardiologist of international fame was heard recently to remark that over one-half of his consultations were with individuals who have been handicapped through a wrong diagnosis of heart disease because of the presence of an accidental murmur or an enlargement within physiologic limits. When one realizes the careers that are halted, the women who have been denied moth-

erhood because of these accidental findings, diagnosis of cardiac disease must rest upon the surest of grounds.

This diagnosis is not completed upon the recognition of a valve deformity, a muscular insufficiency, or an arterial lesion. Of even greater importance is the determination of the etiologic factor, its present activity, and the evaluation of myocardial efficiency. The three main groups etiologically are rheumatic heart disease, syphilitic cardiovascular disease, and arteriosclerosis.

Rheumatic lesion: The heart disease of youth and young adult life results pre-eminently in deformities, especially of the mitral valve and, less frequently, of the aortic.

Syphilitic heart disease, usually in the third and fourth decades, is essentially a disease of the aorta and aortic valve ring.

Arteriosclerosis, from the fifth decade on, results in hypertension, myocardial degeneration, and nephritis.

Occurring secondarily to any of these lesions, especially the rheumatic and arteriosclerotic, or as a primary affection, are the bacterial endocarditis group produced by all the cocci. Of especial importance is the so-called subacute bacterial endocarditis, usually a *Streptococcus viridans* infection, often unrecognized because of slight evidences of infection and prolonged course. The determination of these factors depends upon a careful, detailed history, clinical observation, and keen clinical judgment.

The diagnosis of chronic cardiac and vascular lesions rests upon well defined physical signs from which accurate pathological diagnosis may be made. As a part of these physical signs X-ray has become greatly used in the form of orthodiagraphy and teleoradioscopy, to accurately record the size and configuration of the heart and

great vessels. By these methods accurate measurements may be made of the plane in which the chest is examined, usually anterior-posterior, although the lateral plane may often be of as much value. These data, when obtained with proper precaution, are absolutely accurate and have to a large degree supplanted the observations made by percussion.

The precautions to be taken in regard to the evaluation of these findings are: First, those of technic, familiar to all radiologists, namely, the position of the patient, the period of the respiratory cycle, changes in the abdomen, such as distention with cardiac displacement, etc.; second, there is a considerable physiologic variation in both size and shape.

Bardeen's tables, or, with greater detail, Groedel's tables (*Grundriss und atlas der Röntgendiagnostik in der inneren Med.*, 1914) show the wide physiologic variations in the measurements in different age, height, weight, and sex groups.

The simplest classification of normal variations in configuration are:

The usual oblique heart;

The horizontal heart, with increased transverse measurements, usually present in the broad-chested individual;

The vertical heart, in which the area is elongated with narrow transverse measurement, usually found in the chest of long, flat type;

And, finally, the *cor pendulum*, in which the heart is not displaced downward, but is as if suspended by the great vessels and the apex does not rest upon the diaphragm. In this type a tracheal tug may be present.

With these facts in mind, the roentgen ray gives accurate measurement and an outline of the configuration, with a graphic record of these facts. Within these limitations the accuracy of the X-ray is unquestioned, but the final diagnosis of even the most simple lesions must rest upon these

facts, added to those derived by other methods of diagnosis.

Bardeen has made it possible to determine accurately the cardiac volume upon the basis of the measurements of the cardiac silhouette.

It is to be hoped that the time is not far distant when plates taken at the height of systole and diastole will make possible the determination of the actual cardiac output during each systole. Such determination will undoubtedly be of great value in the determination of cardiac efficiency.

Until such advances occur the opinions formed upon the roentgenologic findings are limited to the determination of variations of size and form.

DON C. SUTTON, M.D.

A COMMUNICATION TO THE MEMBERS OF THE RADIOLOGICAL SOCIETY OF NORTH AMERICA

Subject: *Library of Film Studies*

One of the objects of the Radiological Society of North America has been the establishment of a library of film studies covering the science of radiology and its connection with all the allied branches of medicine.

The form adopted was a reproduction of the original film or plate on a 5×7 film, mounted in a mat 8×10, having two windows in it, one 4½×5½ for the film, the other 5½×1¼ for the legend. The heading is typed in capitals and underlined. The legend should not exceed six lines and is typed in small type, a single space being allowed between the heading and the legend. A reduction is first made of the original film or plate and from this the reproduction is copied. The finished product is a trans-

parency which, when arranged on an illuminating box, is an exact reproduction of the original film.

Some members have adopted this method for their own libraries and have sent loan exhibits made up in this form for the scientific exhibit at the annual meeting of the Society. The mats are obtainable through Mr. J. R. Bruce, 2429 University Avenue, Saint Paul, Minnesota. They cost \$12.00 a hundred, and are made with either vertical or horizontal position of the opening for the film.

There are three ways in which a member may contribute to the library: he may send the original films (in the flat) or plates to the Librarian at Post Office Box 184, Rochester, Minnesota; make and forward the reductions, or make up and send the transparencies. In the former case, the original films or plates will be returned. With the originals or reductions sufficient clinical data for the heading and the legend should be sent. In the latter two cases the reductions or the transparencies will be retained in the files of the Society.

Because of suggestions that have already been made, each contributor should state his objection or non-objection to reproduction in any form or use of his contribution in any manner other than for reference and study.

It has been the hope and ambition of some that this collection might be developed to the point that it would take its place with the Museum of the Royal College of Surgeons, the Surgeon General's library at Washington and similar institutions as a factor in the advancement of our branch of the science of medicine.

Through its members the Society could offer to national, state, county and other meetings of scientific societies, exhibits that could do much to educate the profession in general in the application of the X-ray to diagnostic problems. By similar methods

members could offer assistance in the procuring of exhibits for propaganda campaigns such as "cancer week," tuberculosis work and others of like import.

Our own scientific exhibits at the annual meeting have already attained a high standard of excellence; this standard must be maintained and improved. Through these exhibits the members with greater opportunity can do much to educate those of more limited opportunity and thus raise the standard of roentgenologists on this continent.

International exchanges of exhibits have already been attempted on our part. Our exhibit at the International Congress in London was much appreciated and admired. While some of the members have contributed, the response to our appeals has not been as general as the officers of the Society would like to see it.

I ask the members to go through their files of rare and interesting cases and send the best of them to the Society for the library. If it is preferable to send the transparencies made up, the Society will appreciate it. If this is not possible, send the reductions or let us have the originals and we will arrange to have the reductions made.

We are already active on the preparations for the annual meeting and would like to have your contribution in plenty of time to prepare it for this event.

Very truly yours,

E. W. ROWE, M.D., *President.*

SECOND ANNUAL MEETING OF AMERICAN ASSOCIATION OF REGISTERED RADIOLOGICAL TECHNICIANS

This Second Annual Meeting, which was held at Chicago, in April, had a four-day program of papers, demonstrations, plant inspections, and study of special problems. Some of the papers presented were as fol-

lows: Radiological Organizations, by Dr. Benjamin H. Orndoff; Record Systems in the Private Office and Hospital, by Dr. E. S. Blaine, and Ethics of the Radiological Technician, by Dr. George M. Landau.

The meeting was well attended, enthusiastic, and voted a complete success. It is hoped that from year to year physicians will recognize the importance of employing technicians who are members of the organization, and make it possible for them to attend the meetings.

The Secretary is Mr. F. A. Senechal, 212 Metropolitan Building, St. Louis.

THE NEW ORLEANS MEETING

POST-MEETING CRUISE TO CUBA, HONDURAS, AND CANAL ZONE

Those who expect to attend the New Orleans meeting of the Radiological Society will be interested in the plans being made for a cruise in the S. S. *Parismina* of the Great White Fleet of the United Fruit Company. It was at first expected that we would use the S. S. *Cartago*, but owing to that vessel's going into dry dock, we will have its sister ship, the *Parismina*. This palatial steamer has been chartered for an exclusive party (provided enough register

for the cruise) of agreeable people, for a 16-day cruise immediately following the close of our meeting on December 3. The boat is due to leave New Orleans at 11 A. M., Saturday, December 3, according to present plans. The itinerary is given below.

The listed rates include all the principal items of expense such as fare, bed in double cabin, meals (*a la carte* or *table d'hôte*, at no extra expense) on ship at all times, steamer chair, use of ship as hotel in all ports, motor and launch trips while at Havana, Panama Canal inspection trip by rail across Isthmus, overnight stay in hotel and meals on Pacific side. Also a banana plantation trip at Puerta Castilla will be included if time and conditions permit. Items of a personal nature, such as tips, laundry, etc., will, of course, be extra.

All cabins on this vessel are outside and open to sea air and sky.

State rooms will be assigned in the order that applications are received, and as long as space is available. Applications must give full names of all passengers, kind of accommodations desired, and be accompanied by check for \$50.00 deposit for each person.

Make checks payable to United Fruit Company, but send the check to *me*, as *all*

<i>Ports of Call</i>	<i>Arrive</i>	<i>Depart</i>
New Orleans		Sat., Dec. 3, 11 A. M.
Havana, Cuba	Mon., Dec. 5, A. M.	Wed., Dec. 7, A. M.
Cristobal, C. Z.	Sat., Dec. 10, P. M.	Mon., Dec. 12, P. M.
Puerta Castilla, Hond.	Sat., Dec. 17, A. M.	Sat., Dec. 17, P. M.
New Orleans	Mon., Dec. 19, P. M.	

RATES FOR THE CRUISE ARE AS FOLLOWS

Minimum—Saloon deck	\$205.00 per person.
Maximum—Cabin deck	230.00 per person.
Maximum—Cabin deck (with bath).....	290.00 per person.
Suite de luxe, Promenade deck.....	720.00 for 1 or 2 persons.

These rates include the Revenue Tax of \$5.00 per person.

reservations must pass through my office. The second deposit of \$100 is required to be paid by September 1 and the balance by October 1.

Special circulars, cabin plans, general literature and information may be had by writing me. The actual management of the planning of this cruise is in the hands of an experienced man, who has handled several satisfactory trips for our members. The personnel of the party will be passed upon by me. The right is reserved to decline acceptance of reservation of any applicants. This will be a most enjoyable trip, one long to be remembered by all who make it. The slogan of the United Fruit Co. is "Every passenger a guest."

Early application will insure consideration as above stated.

Cordially,

I. S. TROSTLER, M.D.

*Manager of Commercial Exhibits
and Transportation, 812 Marshall
Field Annex, Chicago.*

ADDITIONAL HONORS FOR A MEMBER OF THE SOCIETY

Dr. Leon J. Menville, Counselor for Louisiana, is President-elect of the Louisiana State Medical Society, following upon five successive terms as Chairman of the House of Delegates. He has also been re-appointed on the State Board of Medical Examiners for another six-year term, at the expiration of which he will have been a member of this body for some nineteen years.

Dr. Menville has been active in the matter of clearing his State of commercial laboratories and "quacks." Rewarding his unremitting efforts and those of the attorney for the State Board of Medical Examiners, the Assistant Attorney-general, the State Finance Commissioner, and others, the United States Supreme Court has upheld

the Medical Practices Act of Louisiana, a decision which constitutes a victory for organized medicine in every State. In a case which has become famous in court annals, this present Supreme Court decision not only upholds the constitutionality of the law, but maintains the right of the courts to injunction proceedings and to punish for contempt of court; it also upholds the legality of criminal court convictions for alleged violators of the law. The roentgenologists of the State are gratified to have won a decision over commercial laboratories and irresponsible users of the X-ray. Chiropractors are not barred from Louisiana under the law which has just been upheld. That law merely requires them to pass the examinations and meet the standards of the State Board of Medical Examiners, as a physician, surgeon, or other practitioner is required to do.

Dr. Menville is a member of the local committee, already actively planning for the coming Annual Meeting of the Society in New Orleans.

BOOK REVIEWS

PNEUMOCONIOSIS (SILICOSIS). By HENRY K. PANCOAST, M.D., and EUGENE P. PENDERGRASS, M.D. Pages 186. Published by Paul B. Hoeber, Inc., New York, 1926. Price \$4.00.

This excellent monograph contains a complete description of the roentgenologic appearance of the lungs in the various stages of pneumoconiosis. There are also chapters on "Dust"; The Preventive Measures to be Used; The Pathology of the Disease; The Occupation in which the Process is Likely to Occur and the Probable Effect of a Coincident Tuberculosis. A complete bibliography is appended.

The book is carefully arranged, well illustrated, and presents the subject in a com-

lows: Radiological Organizations, by Dr. Benjamin H. Orndoff; Record Systems in the Private Office and Hospital, by Dr. E. S. Blaine, and Ethics of the Radiological Technician, by Dr. George M. Landau.

The meeting was well attended, enthusiastic, and voted a complete success. It is hoped that from year to year physicians will recognize the importance of employing technicians who are members of the organization, and make it possible for them to attend the meetings.

The Secretary is Mr. F. A. Senechal, 212 Metropolitan Building, St. Louis.

THE NEW ORLEANS MEETING

POST-MEETING CRUISE TO CUBA, HONDURAS, AND CANAL ZONE

Those who expect to attend the New Orleans meeting of the Radiological Society will be interested in the plans being made for a cruise in the S. S. *Parismina* of the Great White Fleet of the United Fruit Company. It was at first expected that we would use the S. S. *Cartago*, but owing to that vessel's going into dry dock, we will have its sister ship, the *Parismina*. This palatial steamer has been chartered for an exclusive party (provided enough register

for the cruise) of agreeable people, for a 16-day cruise immediately following the close of our meeting on December 3. The boat is due to leave New Orleans at 11 A. M., Saturday, December 3, according to present plans. The itinerary is given below.

The listed rates include all the principal items of expense such as fare, bed in double cabin, meals (*a la carte* or *table d'hôte*, at no extra expense) on ship at all times, steamer chair, use of ship as hotel in all ports, motor and launch trips while at Havana, Panama Canal inspection trip by rail across Isthmus, overnight stay in hotel and meals on Pacific side. Also a banana plantation trip at Puerta Castilla will be included if time and conditions permit. Items of a personal nature, such as tips, laundry, etc., will, of course, be extra.

All cabins on this vessel are outside and open to sea air and sky.

State rooms will be assigned in the order that applications are received, and as long as space is available. Applications must give full names of all passengers, kind of accommodations desired, and be accompanied by check for \$50.00 deposit for each person.

Make checks payable to United Fruit Company, but send the check to *me*, as *all*

<i>Ports of Call</i>	<i>Arrive</i>	<i>Depart</i>
New Orleans		Sat., Dec. 3, 11 A. M.
Havana, Cuba	Mon., Dec. 5, A. M.	Wed., Dec. 7, A. M.
Cristobal, C. Z.	Sat., Dec. 10, P. M.	Mon., Dec. 12, P. M.
Puerta Castilla, Hond.	Sat., Dec. 17, A. M.	Sat., Dec. 17, P. M.
New Orleans	Mon., Dec. 19, P. M.	

RATES FOR THE CRUISE ARE AS FOLLOWS

Minimum—Saloon deck	\$205.00 per person.
Maximum—Cabin deck	230.00 per person.
Maximum—Cabin deck (with bath).....	290.00 per person.
Suite de luxe. Promenade deck.....	720.00 for 1 or 2 persons.

These rates include the Revenue Tax of \$5.00 per person.

Prostatic calculi.—The authors classify prostatic calculi as follows: (a) endogenous; (1) associated with prostatitis; (2) with prostatic hypertrophy; (3) with tuberculous disease of the prostate; (4) with trauma plus infection; (b) exogenous calculi having origin in kidney, bladder, urethra, or diverticula of bladder; (c) ex-endogenous, having a combination of both endogenous and exogenous origin.

Case report: Patient, aged 54, complained of swelling at base of penis, urethral discharge and dribbling for past 12 years following a perineal injury. A perineal abscess had developed and was drained; later a fistula had developed. Defecation was painful.

Examination revealed a hard mass about the size of a hen's egg. X-ray showed a large stone shadow in the region of the prostate and kidney stone in the left kidney. On operation, a large stone the size and shape of a hen's egg and consisting chiefly of phosphate with some oxalates and carbonates, was removed.

This case is of particular interest because of its unusual aspects—the enormous size and protrusion of the stone through the perineum, also the exogenous and endogenous etiologic background.

ROBERT A. ARENS, M.D.

Prostatic Calculi: With Case Report.
Henry B. Podlasky and David V. Elconin.
Urologic and Cutaneous Review, January, 1927, p. 42.

X-ray therapy of female genital tuberculosis.—In the women's clinic of the University of Freiburg, genital tuberculosis is treated with medium doses of roentgen rays (180 to 200 K.V., 2.5 to 3.0 ma., 0.5 to 1.0 Cu. plus 1.0 Al., 50 cm. F.S.D., 24 × 24 cm. field, 1 E.D., equal to 170 e corresponding to Friedrich). The author reports 123 cases observed between 1918 and 1926. There were 65 cases of tuberculosis of the adnexa and 35 cases of tuberculosis of the bladder and kidney. Out of these, 47, 19, 18 were cured; 17, 7, 0 im-

proved; 1, 2, 2 had recurrences, and 0, 7, 3 died. A tabulation of the various applied doses and the respective results indicates that approximately 25 per cent E.D. over the anterior and posterior abdomen offers the best chance for a cure.

E. A. POHLE, M.D.

Regarding Therapy of Genital Tuberculosis in the Women's Clinic in Freiburg. M. Wesseling. *Strahlentherapie*, 1927, XXIV, 459.

Foreign bodies in the eyes.—Twelve cases of foreign body in the retina which caused little or no impairment of vision were reported by Hermann Knapp in 1882, and he noted a thirteenth case of which he had knowledge. He added, however, "that we should not forget that the toleration, even if once established, is not illimited, as the foreign body after any number of years may become loose and produce irritation, or without coming loose may produce repeated attacks of internal inflammation." Examples of both of these conditions are on record.

Numerous authors are quoted, with the leading facts concerning their reported cases, to which Bulson adds three cases. Of localization with the X-ray he says: "After the roentgen ray came into use, it became practically universal to locate foreign bodies within the eye by its aid, and if the foreign bodies could not be withdrawn with a magnet, the eye was enucleated. In consequence, very few cases have been reported within the last few years in which foreign bodies have been retained within the eye." Notwithstanding the exceptions constituted by the cases quoted, the prognosis is considered unfavorable by nearly all writers on the subject of the retention of foreign bodies within the eye. The literature is extensively quoted in support of this statement.

The present author's conclusion is marked by nicely balanced judgment as to the course to be followed in any given case. He says: "Every case is a law unto itself, but most of our teaching concerning the subject under discussion has been toward too much radicalism

in electing intervention in foreign body cases. The plea, therefore, is made that there should be less haste in advising enucleation, and less general inclination to be energetic in endeavors to extract foreign bodies from the posterior segment of the eye. More time and thought should be given to an analysis of the conditions presented in each individual case, and the possibilities that may follow intervention and non-intervention. Furthermore, more time and care should be given treatment. The danger of sympathetic inflammation in the average perforating injury with retention of a foreign body in the eye is as great after the foreign body has been removed as it was before, and in either case the well-trained ophthalmologist will recognize the time for the cessation of conservatism."

With the paper is published the lengthy discussion it occasioned upon its reading before the Section on Ophthalmology of the American Medical Association, in 1926. Ancil Martin, of Phoenix, Arizona, concludes "that the tolerance of the eye to intra-ocular foreign bodies is dependent on three factors: (1) their sterility; (2) their location, and (3) their character." He summarizes his findings in 282 cases. John Green, of St. Louis, reports a case of a copper fragment in the vitreous humor, demonstrable with the X-ray. After some weeks of treatment with potassium iodide and atropine "drops," during which the patient was kept in bed, and quiet, the formation of a secondary cataract was noted. At this time the X-ray failed to show any evidence of the fragment, two or three examinations proving negative. The question is asked: "Is it conceivable that a minute copper fragment lodged in the vitreous may be changed to a salt of copper, and thus be no longer demonstrable by the roentgen ray?"

M. INGLEHART.

Tolerance to Foreign Bodies within the Posterior Segment of the Eye. Albert E. Bulson, Jr. Jour. Am. Med. Assn., Dec. 18, 1926, p. 2071.

Hydatid cysts.—The author reports that spontaneous recovery occurs in 90 per cent of the cases of hydatid cyst situated in the center

of the lung which open spontaneously into the bronchi, and artificial pneumothorax is rarely required. Sometimes, however, the natural process of recovery is tedious, so that Forlanini's operation appears applicable in the following types of cases: (1) when the natural process of recovery, observed by periodic radiographic examination, is delayed, especially if prolonged expectoration of hydatids is complicated by recurrent hemoptysis; (2) when the cyst situated in the center of the lung gives rise to a persistent cavity containing air and pus, indicating a loss of plasticity in the tissue of the lung surrounding the cyst, due to absence of pleural adhesions; (3) when, in the presence of vomicae, accompanied by deterioration of the general condition, radiologic examination does not show the exact site of the cavity which requires evacuation.

Artificial Pneumothorax in Hydatid Diseases of the Lung. F. Deve. Arch. Med.-Chir. de l'App. Resp., April, 1926, I, No. 2, p. 125. (Reprinted by permission from Brit. Med. Jour., Oct. 9, 1926, p. 54 of Epitome of Current Medical Literature.)

Roentgenotherapy of spinal cord tumor.—

It is suggested to treat all spinal cord tumors before operation, with roentgen rays, preceded and followed by lumbar puncture. The technic used in six cases was 38 to 40 cm. spark gap, 0.5 Zn. plus 2.0 Al., oval field of 3 cm. diameter, 5 to 7 H, three series, six weeks and six to twelve months after the first exposure, repetition. Details, it is said, are to be published in a future article.

E. A. POHLE, M.D.

Therapy of Transverse Lesions of the Spinal Cord. Oskar Weil. Strahlentherapie, 1927, XXIV, 745.

X-ray therapy in urology.—In hypertrophy of the prostate the author advises 70 to 80 per cent of the S.U.D. to the gland. The following fields are treated: (1) perineum; (2) over the symphysis pubis; (3) between the coccyx and anus. He makes the

irradiation in one sitting whenever possible. Tenesmus, which usually results from such massive treatment, can be obviated by proper preparation. The intestines are thoroughly emptied, and an oil retention enema is given every evening for from four to six weeks after the treatment. Belladonna is given for the tenesmus of the bladder. Among 87 cases treated, 68 were completely freed of any trouble. Only the large soft prostatic adenomas react favorably to X-ray.

Carcinoma of the prostate: Possibility of injury to the bladder is very great when treating this condition, as from 90 to 100 per cent of the S.U.D. is required to reach the tumor. The author used the same technic as for hypertrophy of the prostate, but outlined two fields in the region of the symphysis. In addition, the glands must be treated. Induration of tissue is a complication following irradiation of carcinoma of bladder with roentgen rays.

Histologically, carcinomas of the bladder are mostly of the adenoma-carcinoma type, which show the least radiosensitivity and consequently 100 per cent must be delivered to the tumor. Wintz combines roentgen therapy with coppering.

ROBERT A. ARENS, M.D.

Experiences with Deep Roentgen Therapy in Urology. H. Wintz. *Urologic and Cutaneous Review*, January, 1927, p. 9.

Experimental cancer.—The author finds that experimental tar cancer in the mouse's skin can be caused to disappear entirely with almost the same dose as in the case of human cancer of the skin. Disappearance of the tumor is followed by a "radium sore," which also heals up in course of time. Complete healing of the tumor by this method is a strictly local phenomenon. No effect from irradiation on dissemination of the growth was observed in these experiments. Histologically the effects of irradiation were shown by the following appearances, which reached their fullest development in from two to four days:

(1) changes in the tumor cells, consisting in swelling of the nuclei, basophilia of the plasma, and the accumulation of large masses of nuclei; (2) disturbance of mitosis; (3) keratinization; (4) engorgement of the blood vessels. Subsequently the irradiated tumor cells are invaded by other cells, especially polymorphonuclear leukocytes, and later all kinds of connective tissue cells. The arteries in the irradiated area often show much thickening of their walls, whereby the lumen of the vessel is narrowed. After destruction of the tumor the space is occupied by newly formed connective tissue and fat.

Radium Treatment of Experimental Tar Cancer. G. Stoel. *Nederl. Tijdschr. v. Geneesk.*, January 8, 1927, p. 234. (Reprinted by permission from *Brit. Med. Jour.*, March 19, 1927, p. 55 of *Epitome of Current Medical Literature.*)

Irradiation of the ovaries and offspring.—Following a brief discussion of the present status of the treatment of ovarian dysfunction with small doses of roentgen rays, the author reports the case of a young married woman who had been treated for amenorrhea, in October, 1924. Regular menstruation started in December and a two-months pregnancy was diagnosed in June, 1925, a normal child being delivered in February, 1926. The child is healthy and shows no abnormalities.

E. A. POHLE, M.D.

Treatment of the Ovaries with Small Doses of Roentgen Rays, and Pregnancy. F. Heimann. *Strahlentherapie*, 1927, XXIV, 733.

The biliary tract.—In discussing the pathogenesis of cholecystitis, the author gives evidence to show that one neglected idea of its origin is by way of the lymphatics from a pre-existent hepatitis. The frequent association of cholecystitis with other inflammatory

lesions of the portal system, *viz.*, duodenal ulcer, chronic appendicitis, ascending colon stasis, etc., is perhaps explained on this basis.

Cholecystography is defined as a test of the only two functions of the gall bladder known at present, namely: (1) Regulation of the pressure within the biliary tract, and (2), concentration of contained bile. Partly because of this reason, it will detect even early and comparatively mild cases of cholecystitis. As to choice of opaque substance, the author concludes that phenoltetraiodophthalein causes fewer toxic reactions than tetraiodophenolphthalein, and further, that intravenous administration is less toxic than oral administration.

The mechanism of emptying of the gall bladder is discussed, and much doubt is cast upon Meltzer's hypothesis of reciprocal innervation of the gall bladder and the sphincter of Oddi, by the following conclusions:

1. The muscle of the gall bladder seems to play at most a minor rôle in its emptying.

2. The mechanism of emptying seems, on the contrary, to be largely passive, in which the important factors are the elastic recoil of a distensible viscus, gradual washing out of the gall bladder by the ingress of fresh hepatic bile, and change in the intra-abdominal pressure. The gall bladder never empties completely.

3. The control of the outflow of bile from the common duct is dependent chiefly on the tonus of the duodenal wall, and those substances which are supposed to have a somewhat specific effect in emptying the gall bladder probably owe their action chiefly to their ability to induce peristalsis of the duodenum with a resultant milking action of the common duct.

In discussing Dr. Graham's paper, Dr. Hurst, of London, asked how it was possible to explain the occurrence of biliary colic, when a stone was impacted in the cystic duct, except by active spasmodic contractions of the gall bladder. He also stated that in diagnosing cholecystitis, it was best to let cholecystography precede the examination by Lyon's method, as when Graham's method failed to give a shadow of the gall bladder, it was clear

that the Meltzer-Lyon method would also fail to procure a specimen of bile from the gall bladder, and might procure a specimen of normal bile even in the face of gross gall-bladder disease.

Professor D. P. D. Wilkie, of Edinburgh, considered that the immunity of the male sex from symptoms following injections of the dye, compared with the female sex, was noteworthy, and possibly of some significance in relation to the comparative immunity of the male sex from biliary disease. He went on to say that the retention by the gall bladder of a constant residuum of content might explain in some measure the liability of the gall bladder to calculous disease, and also the relatively silent course which gallstone cases so often pursue.

Dr. Illingworth, of Edinburgh, believed that oral administration of the dye was obviously the method of choice, but until, however, complete absorption of the drug from the intestine could be insured, accurate results could be hoped for only by intravenous injection.

WALLACE DUNDAS MACKENZIE, M.D.

Discussion on Some Recent Developments in Our Knowledge of the Biliary Tract: Opening papers. Evarts A. Graham and Arthur F. Hurst. Discussed by D. P. D. Wilkie, C. F. W. Illingworth and others. Brit. Med. Jour., Oct. 16, 1926, No. 3432, p. 671.

Diverticulum.—Patient, aged 66, had complained for two years of frequent and difficult urination. Abdominal examination revealed the presence of a large mass extending to the left of the umbilicus, thought to be a large distended bladder. It was tender on palpation. Two cystograms were taken, twenty-four hours apart. The first showed a large distended bladder with a large indefinite shadow to the left of the bladder. When it was repeated, the diverticulum did not show. On operation, a large diverticulum was found which contained twelve ounces of pus. It did not communicate with the bladder. With both the bladder and the diverticulum open, the opening through which the diverticulum had previously connected with the bladder

was located high on the left lateral wall of the bladder. It was entirely closed at this time.

ROBERT A. ARENS, M.D.

Diverticulum of the Bladder: Report of an Unusual Case. Ira R. Sisk. Jour. Urol., February, 1927, p. 255.

Successful radiation treatment.—This case is reported, according to the author, because of the absence of early and extensive metastases and the fact that the patient is clinically well six and a half years after the treatment.

The patient was a man 34 years of age, with a large mass in the nasopharynx, showing evidence of recent hemorrhage. A further large mass occupied the area behind the posterior pillar of the fauces on the left side and a similar but smaller mass was on the right. The glands in the posterior triangle of the neck on both sides were enlarged and indurated, the larger on the left. The diagnosis was confirmed by biopsy. Radium was implanted into the nasopharyngeal neoplasm and into the mass of the neck. As is frequently the case when a surgeon reports treatment with radium, many essential factors of the dosage are left out of the report. In this case, the statement is made that a 50 mgm. tube of radium bromide was placed in each of these areas. This is equivalent to 26.75 mgms. of radium element in each area. No statement is made as to screening. The time *in situ* was six hours. Five days later, one Sabouraud pastille dose of X-ray was given to each side of the neck through 3 mm. of aluminum as filter, with the central rays directed toward the nasopharyngeal region. One week later the man's condition had much improved. Breathing through the nose had become comparatively easy and deafness was diminished. Five days later the X-ray was repeated, and ten days later radium was again inserted for six hours into the much shrunken growth. This gave seventeen days between the radium applications. Nine days later, *i.e.*,

twenty-six days from the beginning of the treatment, the post-nasal space was found to be free of growth. Ten further X-radiations were given within a period of five months. The nasopharynx remained free of growth and the glandular induration and enlargement completely disappeared. There have elapsed, at the time of the report, six and a half years since the initial treatment, and there is no evidence of either primary growth or metastases. The patient appears well and healthy, with only a few telangiectases on the neck from the X-radiation.

H. J. ULLMANN, M.D.

A Case of Lymphosarcoma of the Nasopharynx Treated with Radium and the X-rays. Hector A. Colwell. Lancet, Feb. 26, 1927, No. 5400, p. 437.

Hilum tuberculosis.—The usual descriptions of actual lesions of hilum tuberculosis as demonstrated by the roentgen ray are somewhat vague, both as to the site and appearance. The author approached the study of abnormal changes in the lungs in two ways: (1) to discover what elements of lung structure might be differentiated under the simplest conditions, and (2) the effect of cardiac movement on the lung detail. For the first phase he examined 400 pairs of excised lungs, both anatomically and radiologically. He found that practically every case of hilum tuberculosis showed some apical involvements. Calcium infiltration is the sole distinctive roentgenographic indication of the site of lymph nodes within the limits of the mediastinum. Calcium-free glands, however enlarged, failed to cause perceptible intensification of the mediastinal shadow.

As regards the second phase, he showed that in only one case did the nodules project beyond the zone occupied by the crossing, branching, and overlapping vessels, and an X-ray film, unless taken at 0.05 seconds, could not show clear detail because of the movement.

The protrusion of the mediastinal wall beyond the shadow of the spine and sternum by

caseous lymph nodes is rare except in fatal infantile cases. Shadows simulating calcification are thrown by vessels axially radiated.

There is no symptom complex which is characteristic of tuberculosis of the tracheobronchial lymph node, but the quantitative tuberculin reaction gives important indication as to the activity of the lesions in individuals, more especially in infants.

ROBERT A. ARENS, M.D.

The Diagnosis of Tracheobronchial Tuberculosis. F. Maurice McPhedran. Am. Jour. Med. Sci., February, 1927, p. 245.

Small doses of roentgen rays.—The author has seen good results from small doses of roentgen rays ($\frac{1}{4}$ to $\frac{1}{2}$ to 1 H, 25 to 75 cm. F.S.D., 1 to 3 Al., 0.5 Zn. plus 1.0 Al.) in periostitis, bronchitis, diabetes (?), pelvic inflammatory disease, surgical tuberculosis, and hemolytic anemia; failures were cases of chronic pneumonia, endocarditis, and pernicious anemia.

E. A. POHLE, M.D.

Regarding Treatment with Small Doses of Roentgen Rays. A. Hellebrand. Strahlentherapie, 1927, XXIV, 728.

Prostatic pathology.—Deep X-ray therapy in cases of carcinoma of the prostate is of no practical value. Symptoms of adenoma of the prostate (hypertrophy of the prostate) are due to the congestion and inflammation of the mucosa, rather than to the enlargement of the gland itself, conditions which are amenable to X-ray treatment. The author advises several courses, each course consisting of four exposures of 1 S.U., as follows: (1) suprapubic area; (2) sacral; (3) perineal, and (4) rectal. The technic over the suprapubic

and sacral areas is 9-inch gap, 5 ma., 3 mm. Al. filter, 8-inch S.T.D., 9 min. Over rectal and perineal areas: 9-inch gap, 5 ma., 3 mm. Al., 11-inch S.T.D., 14 min. He treated 19 patients, 16 of whom improved, as follows: definite alleviation of urgent symptoms, increased freedom in passage of urine, disappearance of dribbling and dysuria, and general improvement in condition. There was no reduction in size of the gland, but the effect was due to the relief of congestion of the mucous membrane. The author advises this therapy only as a palliative means in cases of poor surgical risks. Surgery is the only cure, with but a 3 per cent mortality. X-ray does not sterilize an infected focus.

ROBERT A. ARENS, M.D.

Deep Roentgen Therapy in Disease of the Prostatic Gland. Joseph A. Lazarus. Jour. Urol., January, 1927, p. 37.

Symptoms and treatment of ureteral stricture.—Ureteral stricture is a common condition, encountered by every practitioner. Pain in the abdomen or back is the usual chief complaint, with the result that many patients suffering from this condition are referred to the general surgeon. In women, these symptoms often call for gynecologic examination. The ophthalmologist may be called upon to relieve headache, which is a frequent complaint. Tonsils may be the source of infection in many ureteral strictures. Even urologists may be led astray on account of the easy passage of a catheter. In all cases diagnosis can be made by ureteral catheterization and pyelo-ureterograms. The article is well illustrated by many ureterograms.

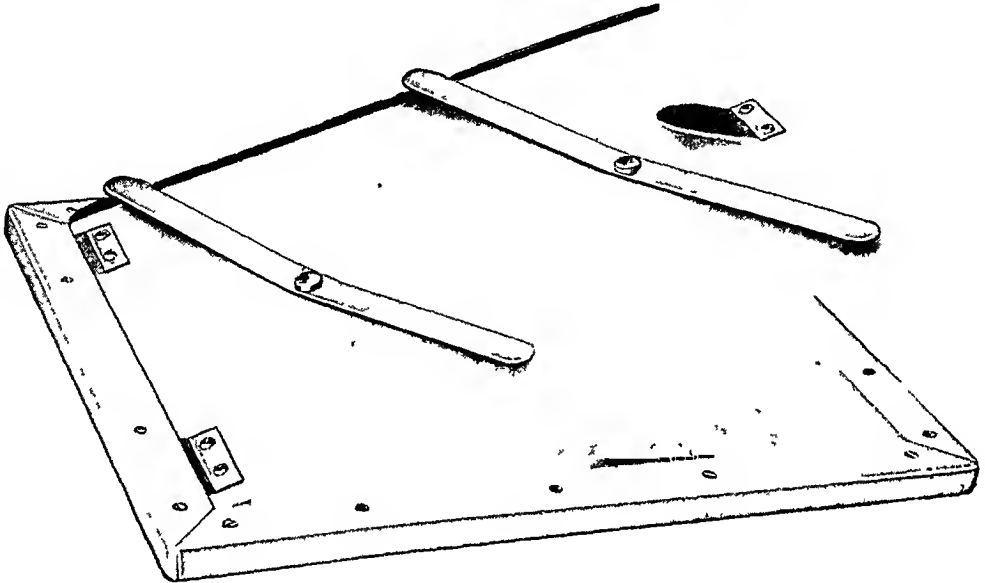
L. R. SANTE, M.D.

Ureteral Stricture in Male and Female. Howard L. Tolson. Surg., Gynec. and Obst., January, 1927, p. 43.

23 Cliff Street COOPER & COOPER, Inc. New York

Special Offer on ~

Intensifying Screens and Cassettes



COMPLETE UNITS AT SPECIAL PRICES

(A complete unit consists of a pair of Intensifying Screens mounted in Cassette)

SIZE	"Crown" Unit	"Eastman" Unit	"Buck" Unit	"Patterson" Unit	"French" Unit
8 x 10	\$21.90	\$21.90	\$21.90	\$24.85	\$28.00
10 x 12	29.10	29.10	29.10	34.50	40.80
11 x 14	35.50	35.50	35.50	43.20	54.00
14 x 17	49.20	49.20	49.20	60.00	69.00

The above Standard makes of Intensifying Screens, as well as Cassettes, are always carried in stock for Immediate Delivery.

C & C Aluminum Contact Cassettes are furnished with above units. Other makes of Cassettes carried in stock and can be furnished at slightly higher prices.

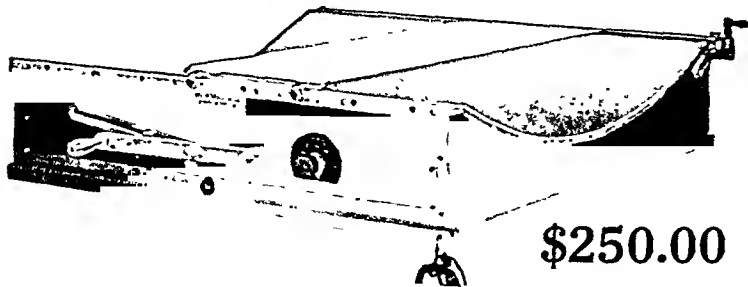
X-RAY SUPPLIES



"TESTED" CHEMICALS

BRADY'S POTTER BUCKY DIAPHRAGM

CURVED AND FLAT TOP STYLES



FOR FINEST RADIOGRAPHIC WORK

Our Potter Bucky Diaphragm was the first on the market. Several thousand satisfied users are our best "ads."

Our fine type grid is a proven success, giving finest detail with the contrast so necessary on obscure cases of gall-bladder, kidney or spine diagnosis. Our speed control is famous for reliability and accuracy.

We believe it is the best value on the market. Made in large quantities, the price is very low for such a high grade accurate mechanism. The electrically welded frame and base make it practically indestructible. No castings to break. No warping. No continual "service" required to keep it in operation. Operates in either horizontal or vertical position. Special devices to center all makes of cassettes. Exposure distance from 16 to 40 inches. Permits stereoscopic exposures. Timing, 1 to 90 seconds. Electric contacts for making exposures automatically while grid is moving. All Bucky's furnished with compression band and winding attachment at no extra charge.

NO X-RAY LABORATORY IS COMPLETE WITHOUT ONE.

FLAT TOP BUCKY

This is made in two sizes, one taking 14x17 cassettes either way, the other taking 11x14 cassettes in one direction and 10x12 cassettes both ways. Smaller size arranged to take head clamps and rods to tilt for head work. Both have electric contact device for operating exposure switch as regular equipment.

Curved top style for 14x17 cassettes; Aluminum top with compression band and winding attachment.....\$250.00 list
Flat top style for 14x17 cassettes; Bakelite top with compression band and winding attachment.....260.00 list
Flat top style for 11x14 cassettes; Bakelite top with compression band and winding attachment.....175.00 list
Curved top Bucky table.....\$160.00 Flat top Bucky table.....\$260.00 Tube stand and rails.....\$250.00

BUCK X-GRAPH PATERSON

EASTMAN SCREENS CASSETTES

A very fast screen, with durable, cleanable surface. Highest grade screens at a low list price, with heavy cash discount for quick payment.

Favorably known for years. Cleanable, fast screens, used for years in large quantities. Smooth surface, cleanable, preferred by some laboratories.

STONE OR ENAMELED DEVELOPING TANKS

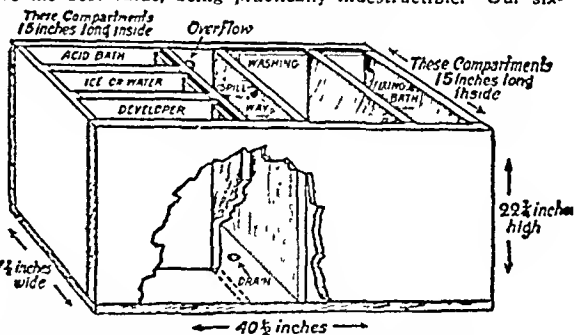
At this season a good tank is a valuable asset, as cold wash water will chill the developer, causing thin films with little detail and very slow development. Soap stone tanks are the best value, being practically indestructible. Our six-compartment tank is considered the best designed tank made. All our regular stone tanks have a chamber next to the developer for ice or hot water, for maintaining the developer at the proper temperature. The five- and six-compartment tanks also have a 4-inch air space next to the washing chamber. The five-compartment tank is excellent for general laboratory use. For hospitals or specialists we recommend the six-compartment tank.

SOAP STONE TANKS 4-Comp. 5-Comp. 6-Comp.

F. O. B. Chicago, Brooklyn or Boston	\$59.00	\$67.25	\$77.30
F. O. B. Virginia factory	\$50.50	\$56.50	\$68.50
ENAMELED TANKS	8x10	11x14	14x17
1-Compartment style	\$22.50	\$27.00	\$30.00
EARTHENWARE TANKS	\$57.50; 3-Comp. style, \$48.00		

F. O. B. Akron.

These prices subject to a 10 per cent discount for cash in 10 days.



DR. GRANGER'S MASTOID LOCALIZER AND SPHENOID MASK

These are the greatest aid in fast, accurate head X-Ray diagnosis ever made. You can duplicate the exact position every time and standardize your work. Impossible to go wrong if used with proper angle blocks furnished. Made for use with any make cassette desired. Prevent mistakes in diagnosis of mastoid conditions and make stereoscopic work unnecessary by using Arcelin position. Specify outside size of your 8x10 cassette when ordering.

Mastoid localizer set with 13 degree double tilt angle block.....\$20.00
Mask for sphenoids and frontal sinus with 17 degree to 23 degree combination block.....13.00

TETRA-IODIDE for

VISUALIZATION OF GALL-BLADDERS

A standard make for intravenous use.
100 gram bottle.....\$8.00
25 gram bottle.....2.50
5 3/4 gram ampules.....5.00

For oral administration.

Per 100	Per 1000
3 1/2 gram capsules.....\$4.00	\$36.00
5 grain capsules.....5.00	\$7.00
5 grain tablets.....7.50	60.00

BARIIUM SULPHATE

Our "Paragon" Barium has been the standard for twelve years. Purest available. Economical. A very dense product giving sharp shadows. "Regular," "Semi-fluff" or fluffy types. Used by hundreds of prominent roentgenologists.

5 lbs.....\$1.75	50 lbs.....\$12.50
10 lbs.....3.50	100 lbs.....20.00
25 lbs.....7.50	300 lbs.....57.00

Freight prepaid on 100 lbs. or over.

DENTAL MOUNTS

We furnish both cardboard and all-celluloid mounts at low prices. Send for quotations on sizes and styles desired. We are sure to save you money and furnish you mounts that please. Heavy cash discounts allowed from standard list prices. Get our latest circular.

FILM & OTHER SUPPLIES

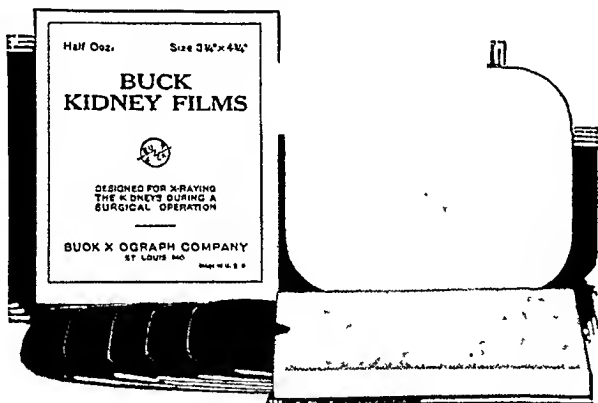
We handle a complete line of X-Ray supplies. We can promise quick shipments of reliable merchandise at low prices and liberal discounts. Get our quotations before you place your order elsewhere. Don't throw away good money. Before you invest—investigate.

GEO. W. BRADY & CO. 802 South Western Ave. CHICAGO

Buck Kidney Films

WITH the rapid progress made in extending the use of X-ray Film in pre-operative surgery, it is only natural that X-ray Film, when properly prepared, should be found of value under certain conditions in operative surgery.

One of the most recent developments in this new field is the advantage offered by raying a kidney after it has been lifted by the surgeon and held in position by gauze strips or tapes. A specially prepared metal backed film is then slipped beneath the kidney.



A radiograph of this kind unquestionably has a decided advantage over fluoroscopy, in addition to which it affords a permanent record.

Use of the Kidney Film will produce far more detail, showing the exact size, number, and position of any stones existing in the kidney than could possibly be secured otherwise, which is a very important feature when applied to radiographs made for the purpose of finding particles of calculi remaining in the kidney after an operation.

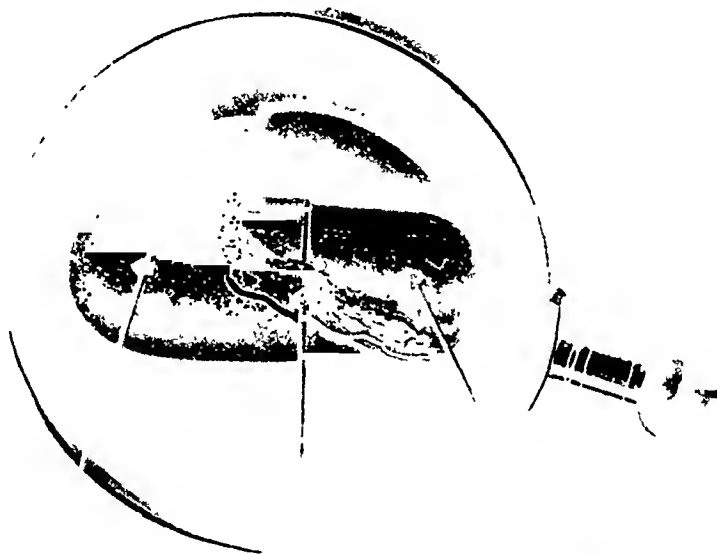
Technical instructions accompany each box of Kidney Films, which are packed 6 films to the box, size $3\frac{1}{4} \times 4\frac{3}{4}$ inches.

BUCK X-OGRAPH COMPANY

SAINT LOUIS, U.S.A.

BUCK

Why SWAN-MYERS Iodeikon Capsules Resist Gastric Digestion



Swan-Myers Iodeikon Capsules are simply gelatin capsules containing 0.25 Gram of Iodeikon (tetiothalein sodium, N. N. R.) manufactured by the Mallinckrodt Chemical Works, and are doubly coated to protect the dye from gastric digestion.

This shows the outer coating which is a hard, highly polished, sugar coating. This coating is not easily cracked nor peeled, and it does not melt or smear when the capsules are handled. Their appearance and size are quite acceptable to the fastidious patient.

The first coating which is put on these capsules is the special Swan-Myers keratin coating which contains no salol or other active medicinal ingredients.

This keratin composition coating *protects* the gelatin capsule containing the Iodeikon, from the acid juices of the stomach, but dissolves in the alkaline fluid of the intestines.

The amount of keratin used on each capsule has been

determined, by X-ray experiments, as that quantity which when given by the suggested method, and to patients having a fairly normal function within the stomach and small intestines, will pass out of the stomach intact, and dissolve fairly quickly within the small intestines.

They are made small to assure the fact that they will not excite pyloric spasm.

SWAN-MYERS COMPANY

These Leading X-ray Houses Supply SWAN-MYERS *Iodeikon* Capsules

THE ENGELN ELECTRIC CO.
Superior Ave. at E. 30th St., Cleveland, O.

THE KELLEY-KOETT MANUFACTURING CO., INC.
22 W. Fourth St., Covington, Ky.

GEO. W. BRADY & CO.
802 South Western Ave., Chicago, Ill.

THE DICK X-RAY CO.
3974-76 Olive St., St. Louis, Mo.

STANDARD X-RAY CO.
1932 N. Burling St., Chicago, Ill.

ACME X-RAY SALES CO.
830 Maison Blanche Bldg., New Orleans, La.

AMERICAN VACUUM CO.
1011 Chestnut St., Philadelphia, Pa.

FRED I. LACKENBACH . . . Biological Depot, San Francisco, Calif.

JOHNSON-NORTH X-RAY Co.
Medical Arts Bldg., Dallas, Texas.

R. P. KINCHELOE
2929 Elm St., Dallas, Texas

W. A. ROSENTHAL X-RAY CO.
412 E. Tenth St., Kansas City, Mo.

STANDARD X-RAY CORP.
320 Liberty Bldg., Des Moines, Iowa

WEINIG X-RAY CO.
23 Allen St., Buffalo, N. Y.

STANDARD X-RAY SALES CO.
178 E. 5th St., New York, N.Y.

WESTERN SURGICAL SUPPLY COMPANY
Los Angeles, Calif.

NOTE—In addition to the X-ray supply dealers, most first-class prescription drug stores and medical supply houses have a stock. Bottle of 100, \$4.00. Canadian prices plus duty.

*All Iodeikon Capsules
contain the same dye*

*The coating on the
capsules is what makes
the difference*

Pharmaceutical and Biological Laboratories
INDIANAPOLIS, U. S. A.



French Intensifying Screens

With Protective Covering

THE ONLY SCREEN sold with any form of GUARANTEE or SERVICE to you!

THE FASTEST SCREEN on the market today, with a range of detail unequaled! (Prove this by your own comparative tests.)

SOLD WITH A WRITTEN THREE-YEAR GUARANTEE for EFFICIENCY, and with a YEARLY RECOVERING SERVICE at \$1.00 a Screen to keep them 100% efficient and spotless far beyond the Guarantee Period!

PRICES:

Size	Each	Pair	Size	Each	Pair
14 x 17.....	\$30.00	\$60.00	8 x 10	\$10.00	\$20.00
11 x 14.....	22.50	45.00	6½ x 8½.....	8.00	16.00
10 x 12.....	16.00	32.00	5 x 7	6.00	12.00

(No Replacement for 3 Years and Longer)

EVERY SALE REGISTERED, and the name of the Purchaser entered upon our Service Records for notification as Screens are due for Recovering Service. This supervision insures your Screens being 100% efficient during the life of our THREE-YEAR GUARANTEE and longer.

FRENCH FLUOROSCOPIC SCREENS ARE ALSO THE BEST, giving a clear, brilliant image with a minimum of X-ray power. Offered at a big saving to you. In all sizes—prices upon request.

Let us send you samples of French Screens and estimate upon your Screen and Cassette requirements



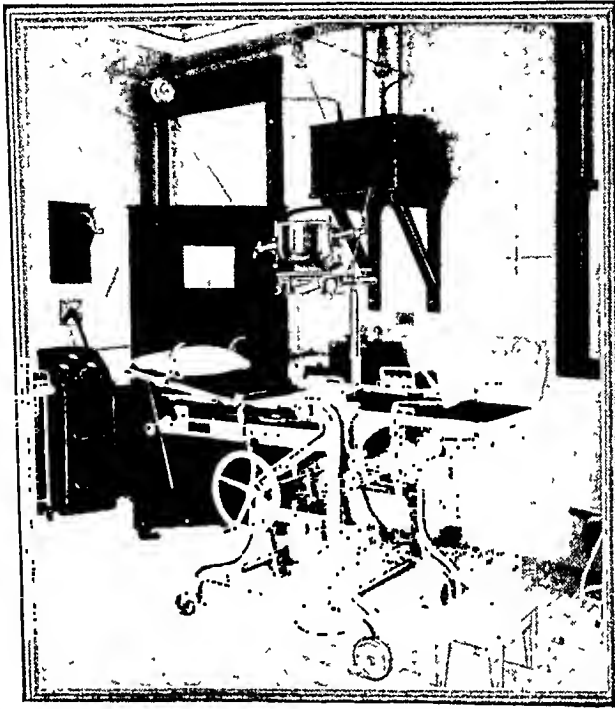
The French Screen Company

507 Hofman Bldg. 2539 Woodward Ave.

Detroit, Mich.

.W.

Essential In Modern Urology



In the past, the obtaining of pyelograms necessitated moving the patient from the cystoscopic room to the X-ray laboratory. The resulting inconveniences, discomfort and inaccuracies were considered necessary evils.

Today, the equipment of the modern urological department includes the Squier Cystoscopic X-ray Table and the Wappler Monex. This combination provides every convenience for both the Urologist and the Roentgenologist.

The Squier Table supports the patient comfortably in any position. The entire urinary tract is always within the X-ray field, so that shifting the patient is unnecessary and catheters are not disturbed.

The Monex X-ray generator operates in silence; sparks and fumes are eliminated and very little floor space is required.

***Send for Bulletins 105-A and 107-A,
Describing this Apparatus.***

Wappler Electric Company, Inc.

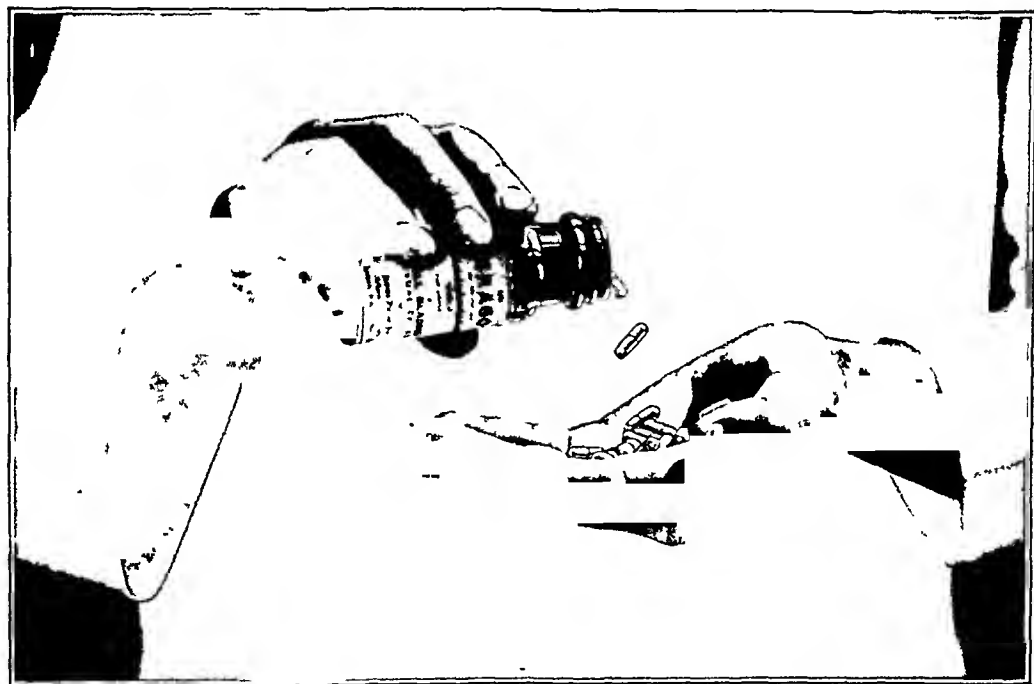
General Offices and Factory:
Long Island City, N. Y., U. S. A.

Show Rooms
173 East 87th St., New York City

.W.

PRAISED BY THE NATION'S

The *Improved*
type of
KERASOL



JAMES
739 Boylston Street
BOSTON

FOREMOST ROENTGENOLOGISTS



Recent refinements have resulted in a Coating with features no other capsule possesses!

LEADING members of the profession have tested the *new* KERASOL—have compared its features with other coatings. They have been impressed by its *transparent, non-porous* qualities—its ability to successfully withstand the attacks of gastric juices, age and temperature—its small size and *high degree of solubility*.

Many of these roentgenologists have written to us describing their experiences—others have expressed their satisfaction, personally. All are agreed that KERASOL today embodies many distinct advantages never before found in an enteric coating.

With this improved type of KERASOL, you may be assured of the capsule passing intact through the stomach to the small intestines, where it will readily dissolve *in its pure form*, affording a sharply defined visualization of the gall bladder.

KERASOL capsules are very small and *hermetically sealed*, obviating oxidation of the chemical, while unused. They contain five grains each of the purest type Sodium Tetraiodophenolphthalein obtainable. You may administer them to your patients with strong assurance of a *completely satisfactory* result.

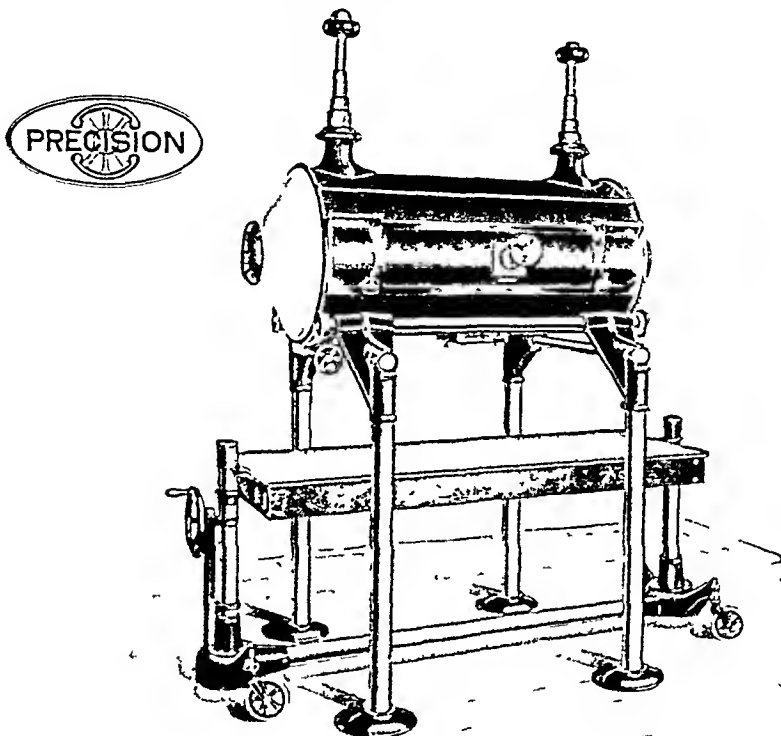
PICKER, INC.

686-88 Lexington Avenue
NEW YORK CITY

253 Alexander Street
ROCHESTER

Warning—

The Acme-International X-Ray Company beg to announce the issuance of the Morrison Patent No. 1,617,267, dated February 8th, 1927, on Deep Therapy X-Ray Tube Holders, a typical illustration of the invention embodying this patent being shown below.



WE are advised by competent patent counsel that this patent covers broadly the idea of X-Ray tube holders of such surface characteristic means as to operate in the substantial absence of corona discharge. It will be appreciated that this is a broad and fundamental patent and is not limited to any specific structure, but covers broadly the use of X-Ray tube holders which substantially eliminate the production of corona about said tube at the operating voltage thereof.

Under the patent laws of the United States, one who manufactures, uses, or sells a patented article may be held as an infringer. Nevertheless, to physicians and hospitals who have purchased infringing tube holders prior to the issuance of this patent, we propose showing our good will

and friendly feeling for the continuation of the use of these tube holders by such physicians and hospitals.

However, infringing tube holders purchased subsequent to the issuance of this patent, and particularly tube holders subsequent to this notice, will out of fairness to the stock holders of the Acme-International X-Ray Company have to be treated in such a way as to protect their rights, and it is suggested that persons contemplating the purchase of such tube holders take these matters into consideration before making future purchases as it is the sincere desire of this Company to continue only friendly relations with all those in the X-Ray field, including those who have bought competitive apparatus.

ACME-INTERNATIONAL X-RAY COMPANY

Cable Address: INTERACME

711 WEST LAKE STREET

CHICAGO, U. S. A.

Exclusive Manufacturers of PRECISION CORONALESS X-RAY APPARATUS



Fewer retakes with Patterson Cleanables

The Patterson Screen Company pioneered the art of Fluorescent Screens and their product is the accepted standard throughout the world.

Write for
Free Test Screen

A SAMPLE Patterson Cleanable of liberal size will be sent without charge to radiologists who wish to test its speed, grainlessness, freedom from lag, and cleanability.

GRAINLESS, freedom from afterglow, speed and uniformity—these are the characteristics of Patterson Cleanable Intensifying Screens.

As a result Patterson Cleanables in the cassette insure not only accurate diagnosis but also reduce retakes to a minimum.

Measured by these high standards Patterson Cleanables are the most economical ever offered to radiologists.

Patterson



Screens

PATTERSON SCREEN COMPANY, DEPT. R, TOWANDA, PA.

X-Rays Without the Dangers of Electric Shock

THE MATTERN MANUFACTURING COMPANY

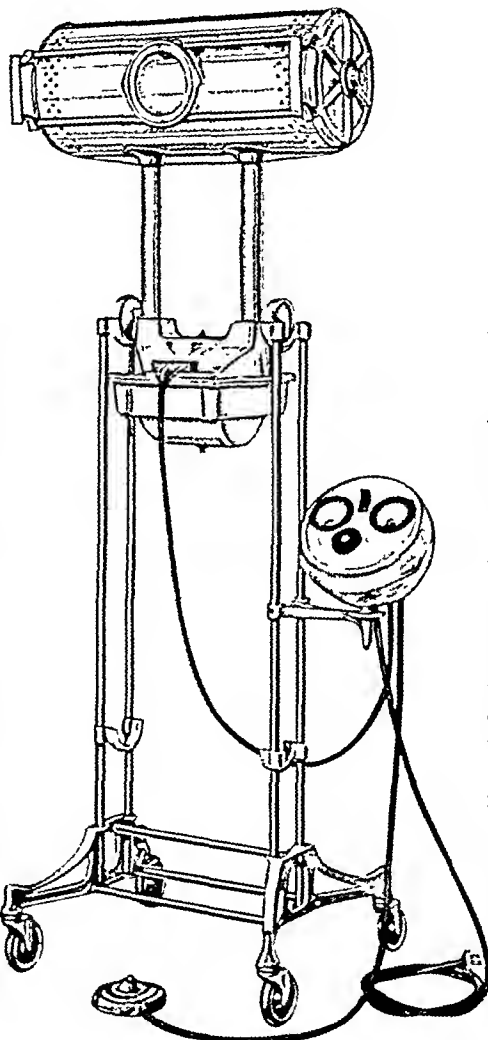
Announcing A NEW DEVELOPMENT IN X-RAY APPARATUS THE "SAFE X"

**An Innovation
in the
X-RAY ART**

**New Possibilities
New Applications**

The medical profession of to-day is burdened with great responsibilities, cares and worries, and no attempt seems to have been made to relieve some of this nervous strain.

The use of the "X-Ray" has considerably advanced the science of the profession, but has also added more responsibilities and hazards. In the light of the foregoing an idea was conceived of an X-Ray machine that could be put thru all the maneuvers used in practise, with greater ease,



**The Trend of
Future
Developments**

**U. S. and Foreign
Patents Pending**

with a single unit, and in a carefree manner, free from the dangers of Electric Shock, and thus the "SAFE X" comes to us a realization of this conception.

Let us tell you all about it. If you now have equipment it will be a new revelation to you. If you have none, it will make you interested.

Our production will be limited and orders will be filled in the order received.

**Distributors
Wanted
High Class Dealers Only**



Mattern Mfg. Co.

2500 Irving Park Blvd.

CHICAGO, ILL., U. S. A.

An Outstanding Contribution to X-Ray Therapy

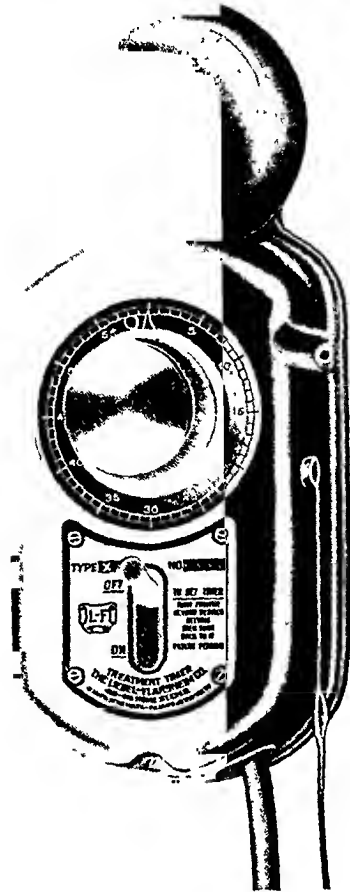
From the earliest days of X-ray therapy there have been two paramount treatment problems—Safety to the patient and Accuracy in dosage. Safety first, then the same Accuracy as that demanded in prescribing drugs.

It remained for L-F Research Engineers, long coöperating with roentgenologists in their offices and hospitals, to solve these problems. In the L-F Treatment Timer they have produced an instrument that makes accurate timing of treatments a certainty, insures maximum safety to the patient, and promotes greater therapeutic results.



TREATMENT TIMER

for Timing X-Ray Treatments



Can be used on any X-ray machine equipped with magnetic switch.

Times from one to fifty-five minutes.

Automatically turns off current at expiration of time period for which it was set, thus eliminating possibility of over-treatment due to failure to turn off machine. A Signal Gong sounds whenever current is cut off.

Maximum safety is insured by a "Patient Release" with which the patient can cut off the current instantly in an emergency.

Current can be turned on or off as many times as desired during treatment; the Timer automatically computes the various periods of actual treatment and cuts off current automatically at expiration of total time.

Produced by an organization having fifteen years experience manufacturing timing devices for the medical profession

THE LIEBEL-FLARSHEIM CO.

410-416 Home Street

Cincinnati, Ohio, U. S. A.

A similar Timer (Type T) is made for Physical Therapy Treatments

Mail Coupon Today

THE LIEBEL-FLARSHEIM CO., Dept. X,
410-416 Home St., Cincinnati, Ohio, U. S. A.

☐ Please send full information on L-F Treatment Timer.

I also desire literature on

☐ Diathermy ☐ Quartz Lamps ☐ Radiant Heat Lamp

☐ X-Ray Apparatus ☐ Electric Scalpel ☐ The Air-O-Vac

☐ Dr. H. H. Young Urological X-Ray Table

Dr. _____

Address _____

Horlick's *the Original* Malted Milk



in X-Ray work

Roentgenologists and technicians in hospitals and laboratories everywhere have found Horlick's Malted Milk to be the most satisfactory medium for the suspension of Barium Salts. It not only holds the Barium in uniform and complete suspension, but is palatable and offers the patient easily-digested nourishment.

Our X-Ray booklet free

Horlick's Malted Milk Corporation
Racine, Wisconsin

The Post Graduate Hospital and Medical School

2400 S. Dearborn Street
CHICAGO, ILL.

Announces Practical Instruction
in all branches of

X-RAY WORK

Including DEEP THERAPY,
Treatment of Malignancy with X-RAY
and RADIUM
FOR PHYSICIANS

A Special Course In

DIAGNOSIS FOR PHYSICIANS

Also inexpensive short courses in the
fundamentals of

X-Ray and Physiotherapy Technique
given to Physicians' Nurses and Radiologists' Assistants.

B. C. Cushway, D.D.S., M.D.

New Classes are started on
the First of Each Month.

For full particulars and information on X-ray Courses
other post-graduate courses for Physicians and instruction
for Laboratory Technicians, write to

**POST GRADUATE HOSPITAL AND
MEDICAL SCHOOL**
2400 S. Dearborn St.

Schedule of Prices for Reprints of Articles Published in RADIOLOGY

	100	200	500	1000	Add'l 1000
4 Pages	\$11.75	\$14.50	\$18.00	\$25.50	\$16.25
8 "	21.45	24.00	32.00	41.25	26.00
16 "	33.75	37.50	50.00	68.75	38.75
20 "	44.25	50.00	65.50	91.75	54.50
24 "	53.75	60.50	79.25	111.45	63.50
Cover Add'l	6.75	8.00	11.25	16.25	11.75
Envelopes Printed 8 1/4 x 11 1/2	3.25	4.25	7.00	11.00	9.00

The above prices are for reprints supplied in the page size of RADIOLOGY on the same quality of stock. If smaller or larger sizes are required, special prices must be obtained. Address

J. R. BRUCE, Business Manager

2429 University Avenue

ST. PAUL

MINNESOTA

Comparisons Under The Microscope

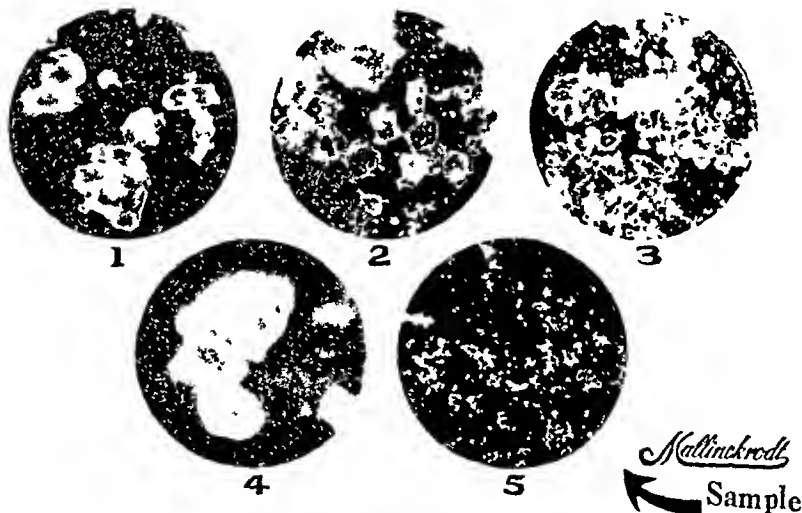
show the vast difference between

Mallinckrodt

BARIUM SULPHATE for X-Ray Diagnosis

and other brands prepared by other methods.

The hard, sharp crystals, which look like broken glass, shown in the first four cuts of the series of micro-photographs can hardly be expected to give satisfactory suspensions and are furthermore very likely to cause irritation to the sensitive linings of the stomach and intestines

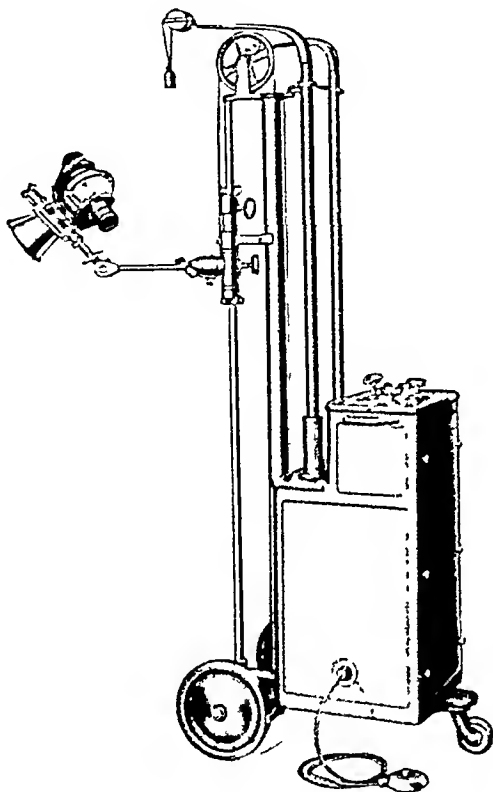


The excellent physical condition of our product is due to our method of manufacture by precipitation from aqueous solution which results in an extremely bulky, soft, impalpable powder; produces superior suspensions that will not settle quickly.

Write for 1 lb. sample to X-ray Dept., St. Louis.

MALLINCKRODT CHEMICAL WORKS
ST. LOUIS MONTREAL PHILADELPHIA NEW YORK

You, Too, Will Approve The Keleket Mobile Unit



When you see the Keleket Mobile Unit you will agree with us that the old Latin expression, *multum in parvo*, describes this unit better than anything we can say.

That it is successfully meeting the demands of the physician for a mobile unit that can be used for all forms of radiographic work, is proven by the gratifying number of orders we are receiving.

Experiments were unlimited as we endeavored to construct a mobile unit that would embody all the important features of the large and more expensive machines, and still be true to the Keleket policy—out of this crucible has been evolved the Keleket Mobile Unit.

Counterbalanced ball-bearing tube stand is universally adjustable—can be turned upside down and placed under stretcher for emergency work.

Unit operates 30 M.A. Coolidge Radiator Tube up to its maximum capacity, occupies minimum floor space, and is easily moved on its ball-bearing wheels.

The quality of this Keleket Mobile Unit is expressed in its appearance—high-grade materials, Keleket craftsmanship, black duco and nickel finish, all combining to give you an apparatus that will maintain the dignity of your office.

Our representative in your territory will gladly confer with you, or write for Leaflet No. 9.

THE KELLEY-KOETT MFG. CO., INC.

222 W. Fourth St.

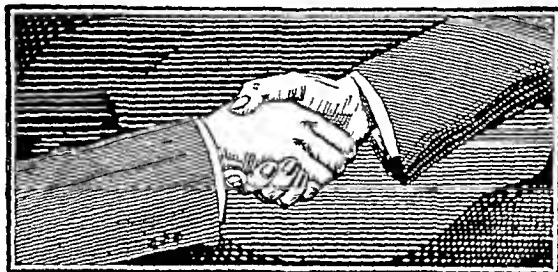
COVINGTON, KENTUCKY, U. S. A.

"The X-ray City"

Keleket
X-RAY EQUIPMENT

THIS SUMMER *when* You Visit NEW YORK

"May we have the pleasure---?"



*I*T would please us greatly to act as your host when you come to New York this summer. Our private cars are at your disposal and we should be glad to escort you to any of the hospitals or other places of interest you might care to visit.

Make our offices *yours!*—Here you will find an atmosphere to which you are accustomed. Competent stenographers are available for your correspondence . . . personal or otherwise.—Private offices for your business conferences.—Assistance in making reservations for the theatres, hotels, steamships and trains.

We should consider it a happy privilege to contribute in this small way to the pleasure of your sojourn in our midst. . . . Come in—we're only five minutes from the Grand Central Station.

JAMES PICKER, INC.

686 Lexington Avenue
NEW YORK CITY

739 Boylston Street
BOSTON, MASS.

253 Alexander Street
ROCHESTER, N. Y.